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OVERSIGHT ON THE SMALL BUSINESS INNOVATION AND RESEARCH PROGRAM, PUBLIC LAW 97-219

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HEARINGS

BEFORE THE

SUBCOMMITTEE ON
INNOVATION AND TECHNOLOGY

OF THE

COMMITTEE ON SMALL BUSINESS
UNITED STATES SENATE

NINETY-NINTH CONGRESS

SECOND SESSION

ON

OVERSIGHT ON THE SMALL BUSINESS INNOVATION AND RESEARCH PROGRAM, PUBLIC LAW 97-219

MERRIMACK, NH—MARCH 3, 1986
WASHINGTON, DC—MARCH 11, 1986

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OVERSIGHT ON THE SMALL BUSINESS INNOVATION AND RESEARCH PROGRAM, PUBLIC LAW 97-219

MONDAY, MARCH 3, 1986

U.S. SENATE,
SUBCOMMITTEE ON INNOVATION AND TECHNOLOGY,
COMMITTEE ON SMALL BUSINESS,
Nashua, NH.

The subcommittee met, pursuant to notice, at 9:15 a.m., at the Merrimack Hilton Hotel, Nashua, NH, Hon. Warren Rudman (chairman of the subcommittee) presiding.

STATEMENT OF HON. WARREN RUDMAN, A U.S. SENATOR FROM THE STATE OF NEW HAMPSHIRE

Senator RUDMAN. The hearing will come to order.

Governor Sununu had another engagement this morning and he is on the way, but rather than delay beyond the 9:15 hour, we will continue. When the Governor arrives, at whatever stage in the proceedings we are, we will then have the Governor come forward.

I have a statement which I would like to incorporate into the committee hearing record today. Let me just summarize that statement of which all of you have a copy.

Back in 1981, it was very apparent that although the statistics showed overwhelmingly that innovation came from small entrepreneurial units or individuals, with the Federal Government spending an enormous amount of money on research, both basic and applied, really was not encouraging that innovation. In fact, in some ways, our policies were almost counterproductive.

That was the genesis of the Small Business Innovation and Research Act of 1982 which was modeled after a very successful program of a very similar nature which had been tried and successfully tried with a very limited number of funds by the National Science Foundation.

The purpose of these hearings is to start to build a record for reauthorization of this bill. I have no doubt from conversations I have had with many who opposed this bill originally on a variety of grounds, most of which I would describe generously as being based on self-interest, but having talked to many people who followed this entire matter back when it was fought out not only in the Senate but particularly in the House where it was sequentially referred to a number of committees as a sure way to kill it, but somehow it had more than a requisite nine lives and it lived—I have talked to those people, and I find much more support now, because demonstrably we have proven what we knew to exist. The statistics, in fact, have proven beyond any doubt.

So, we are hoping that this first hearing, not coincidentally in the State of New Hampshire will start the hearing record, that eventually the chairman of our committee, Senator Weicker of Connecticut will convene hearings in Washington, hopefully, of the full committee on at least one occasion to start the ball rolling to make sure that we not only can reauthorize it, but I think even more importantly we can do whatever statutory change is necessary to make it work better.

I understand from personal conversations that I have had with many that there are some problems, not so much with phase 1 but with phase 2. We want to hear about those this morning. Hopefully, we will have a record that will be replete with the kind of testimony that will be convincing that we can get this reauthorized at the appropriate time without a great deal of difficulty.

[The prepared statement of Senator Rudman follows:]

STATEMENT BY SENATOR WARREN B. RUDMAN
OVERSIGHT HEARING ON P.L. 219,
THE SMALL BUSINESS INNOVATION DEVELOPMENT ACT
SUBCOMMITTEE ON INNOVATION AND TECHNOLOGY
COMMITTEE ON SMALL BUSINESS
MARCH 3, 1986

ON JULY 22, 1982, PRESIDENT REAGAN SIGNED P.L. 97-219, THE SMALL BUSINESS INNOVATION DEVELOPMENT ACT. THAT DAY WAS REWARDING FOR THOSE OF US IN GOVERNMENT AND THE PRIVATE SECTOR WHO HAD WORKED SO HARD TO MAKE THE LEGISLATION A REALITY. AS MOST OF YOU KNOW, THE SMALL BUSINESS INNOVATION DEVELOPMENT ACT WAS DESIGNED TO ADDRESS SOME VERY REAL PROBLEMS:

1. THE LOSS BY THE UNITED STATES OF ITS WORLD LEADERSHIP POSITION IN THE FIELDS OF INNOVATION AND TECHNOLOGY ADVANCEMENT;
2. THE NEED TO STIMULATE THE JOB PRODUCTION CAPABILITIES OF THE PRIVATE SECTOR ;
3. THE NEED TO INSURE THE GREATEST RETURN FOR FEDERAL R&D INVESTMENT AT A TIME OF MOUNTING FEDERAL DEFICITS.

THE COMPETITIVE STANDING OF THIS NATION IN THE INTERNATIONAL MARKETPLACE DEPENDS TO A VERY LARGE DEGREE ON OUR ABILITY TO MAINTAIN AN EDGE IN THE DEVELOPMENT OF NEW TECHNOLOGIES.

SMALL BUSINESS HAS ALWAYS PLAYED THE LEADING ROLE IN THE AREAS OF INNOVATION AND TECHNOLOGY ADVANCEMENT. IT IS IMPORTANT TO RECOGNIZE THAT THE SBIR PROGRAM WAS DESIGNED FOR SMALL HIGH-TECHNOLOGY FIRMS WITH A STRONG R&D CAPACITY.

IN ADDITION, THE SBIR PROGRAM CONTRIBUTES TO NEW EMPLOYMENT OPPORTUNITIES IN THE 80's AND ENCOURAGES TECHNOLOGY TRANSFER TO THE PRIVATE SECTOR IN ITS AWARDS PROCESS. THE RESPONSE HAS WELL EXCEEDED OUR MOST OPTIMISTIC EXPECTATIONS. THE SECOND YEAR RESULTS REPORTED BY THE SMALL BUSINESS ADMINISTRATION SHOW A VERY SUCCESSFUL AND COMPETITIVE PROGRAM. IN 1983 PARTICIPATING FEDERAL AGENCIES WORKING WITH THE SMALL BUSINESS AGENCY RECEIVED AND RESPONDED TO OVER 84,000 REQUESTS FOR SOLICITATIONS AND PROCESSED 8,562 PROPOSALS. MANY PROJECTS REVIEWED AND RECOMMENDED FOR FUNDING FAR EXCEEDED THE FUNDING AVAILABLE.

I AM ESPECIALLY PLEASED WITH THE RESPONSE IN NEW HAMPSHIRE. DURING THE FIRST TWO YEARS OF THE PROGRAM, THE STATE RECEIVED 17 AWARDS TOTALING $1.8 MILLION IN SBIR FUNDING. IN 1984 NEW HAMPSHIRE HAD NINE RECIPIENTS OF PHASE I AND PHASE II AWARDS VALUED AT $1.5 MILLION.

WHILE THERE HAVE BEEN SOME PROBLEMS WITH THE IMPLEMENTATION OF THE PROGRAM, IMPROVEMENTS IN THE ADMININSTRATION OF THE SBIR PROGRAM WILL COME AS THE PROGRAM MATURES.

FINALLY, WE ARE ALL PAINFULLY AWARE OF FEDERAL BUDGET PROBLEMS. THE NEED TO CONTINUE OUR INVESTMENT IN RESEARCH AND DEVELOPMENT WAS CLEAR; HOWEVER, THE NEED TO HOLD DOWN GOVERNMENT SPENDING WAS EQUALLY CLEAR. ONE SOLUTION TO THE PROBLEM WOULD NATURALLY BE TO REALIZE A GREATER RETURN FOR EACH DOLLAR INVESTED. STUDIES DOCUMENT THE FACT THAT SMALL BUSINESSES ARE FAR MORE COST EFFECTIVE THAN LARGER COMPANIES AND UNIVERSITIES WHEN ENGAGING IN RESEARCH, PRODUCING UP TO 24 TIMES MORE INNOVATIONS PER RESEARCH AND DEVELOPMENT DOLLAR THAN THEIR LARGER COUNTERPARTS.

THE PURPOSE OF THE OVERSIGHT HEARING IS TO GIVE THE SENATE COMMITTEE A BETTER UNDERSTANDING OF THE OPERATION OF THE SBIR PROGRAM FROM THE PRIVATE SECTOR PERSPECTIVE; IN PREPARATION FOR SBIR'S REAUTHORIZATION WHICH WILL BE FILED IN THE NEXT CONGRESS. PRIOR TO FILING THE LEGISLATION WE HOPE TO IDENTIFY ANY PROBLEMS OR AREAS OF CONCERN THAT MAY NEED TO BE ADDRESSED IN THE LEGISLATION. OUR FIRST WITNESS WILL BE THE HONORABLE GOVERNOR JOHN H. SUNUNU OF NEW HAMPSHIRE.

Senator RUDMAN. I think what I am going to do is ask the first panel to come forward. That is William Fletcher, president of Termiflex in Merrimack—you had a long trip here this morning, Bill; Helen Goodman, associate director of the Small Business Development Center at the university in Durham; and Mr. Brian Walsh, president of Creare Innovations in Hanover. If you could come forward, I think what we will do is to start with your testimony and we will get through your testimony unless the Governor should arrive, in which case what we will do is finish the testimony of that person who is testifying—please be seated—and we will allow the Governor who has a very tough schedule and from whom I am very interested to hear this morning.

So, why don't we proceed. Do you have any order in which you would like to present your statements? I guess Bill Fletcher, an old time friend whom I am glad to have before the committee, if you would like to go ahead. Your complete statements, whatever they are, will be put in the record of this hearing which will be printed. However, to the extent that you can observe the time limitations that staff has told you about, we would appreciate it. We are trying to get a lot done this morning.

So, Bill, why don't you go ahead.

STATEMENT OF WILLIAM FLETCHER, PRESIDENT, TERMIFLEX CORP., MERRIMACK, NH

Mr. FLETCHER. Thank you.

I am Bill Fletcher, founder and president of Termiflex Corp., based here in Merrimack, NH. On behalf of the Smaller Business Association of New England [SBANE], of which I am chairman of the board, and its national affiliate, Small Business United, I am here today to testify on the benefits and accomplishments of the Small Business Innovation Research Act.

I founded Termiflex in 1973. Today, we employ 51 and design and manufacture hand held computer terminals used for industrial and military applications. While Termiflex is not currently involved in the SBIR Program, we are the type of small business that is participating in this very worthwhile Government program.

Senator Rudman, you should be proud of the accomplishments of the SBIR Program. You believed if small business was given the opportunity that they would make significant scientific achievements. And you put this belief into action by leading the fight to pass this landmark legislation.

I am pleased to report that, unlike a lot of legislation, this law is working.

The enabling legislation established the SBIR Program to meet two primary objectives: to encourage and support the greater involvement of the procurement process and to target that support towards development of technology.

During the first 3 years of the program's implementation, Governmentwide, over 25,000 proposals have been received. In 1983 and 1984, over 15,600 proposals for phase 1 projects were submitted nationwide of which 2,158 were submitted by New England based firms. Many of these firms have never before participated in Federal Government procurement at any level.

The trend is continuing. In addition, many of these companies are now participating in Government procurement outside the SBIR Program.

Clearly, the SBIR Program has accomplished its first objective. It is still too early in the program's implementation to show any meaningful statistics of scientific developments that have emerged and are now being commercialized because of SBIR. However, there is plenty of anecdotal evidence that makes us confident that SBIR will foster not only the development of an idea but lead to commercialization of those ideas as well.

One good example of successful collaboration which has led to commercialization is the activities of Collaborative Research in Lexington, MA. This small company which began with 33 employees received its initial award from the National Science Foundation [NSF], for genetic research. Their phase 1 award was $25,000 in 1977, and for phase 2 they received $240,000.

This initial Government investment of only $265,000 led to $42 million invested by Dow Chemical and two public offerings. The company has grown from 33 employees to 135.

This is the type of accomplishment, in terms of scientific contributions, job generation, and leveraged private/public sector dollars, that has led to significant economic development in New England as well as other parts of the Nation. I am confident that as the SBIR Programs matures, we will see more accomplishments like this one.

It takes 7 to 8 years, and in some fields longer, to bring an idea to the marketplace. With the SBIR Program only 3 years old, there is already much excitement about the developments that will occur within the next few years based on scientific breakthroughs achieved SBIR companies in just 3 short years.

Those who initially opposed the proposed legislation based on doubt that there weren't many small business R&D outfits out there who would qualify or participate in the program have been resoundingly proved wrong.

The same holds true for the Federal agencies which were concerned about receiving quality proposals. Today, most, if not all, would testify that the quality of proposals in most cases is equal to other applied research and development proposals they receive from any source.

Scientific development, job generation, economic development, technology transfer, and commercialization will be the rule and not the exception to the SBIR Program. By using NSF experiences, we prove our point. Of the early NSF awards made between 1977 and 1981, total follow-on funding from private sources of which most were investments now exceeds $150 million compared to NSF expenditures for that period of $16 million. This is an astounding 9-to-1 ratio of private sector leverage over the Government R&D investment.

While programs in the Department of Defense and some other agencies may require some follow-on funding from the agency itself in terms of production contracts, the NSF results show what can be done in terms of stimulating private sector investments by the early funding of advanced research for R&D ideas.

Many small R&D startup companies have successfully used the SBIR Program to make the transition to a company that not only develops an idea but designs systems and manufactures and markets them as well. Those firms have successfully used the SBIR Program to bootstrap themselves into a growth mode. Even the small R&D contract shop that chooses to remain small often participates with larger companies to commercialize their ideas.

SBIR critics like to point to multiple award winners as living off the program or taking it over. Some have suggested that a cap be put on companies to prevent any one company from receiving too many awards. Impressions aside, multiple winners represent a small percentage of the total SBIR recipients. If these companies submit good proposals, why should the Government disqualify them from the program? The cap on qualified SBIR companies is as ridiculous as if our Federal forefathers limited Edison to only six inventions.

Excitement about the program is evidenced in the fact that more and more new companies are getting involved. For fiscal year 1985, over 55 percent of the companies receiving awards were new to the SBIR Program. More astounding is the fact that for the fiscal year 1983 phase 1 award recipients, 80 percent of them had no prior experience in the Federal procurement arena whatsoever.

Critics of the SBIR Program would argue that this positive trend is reason enough to eliminate the program and mainstream small companies into the Government procurement process. But this positive trend is misleading. According to The State of Small Business: A Report of the President, May, 1985, the small business share of total Government procurement declined both as a percentage of the total purchases of goods and services and in absolute dollar volume in fiscal year 1983.

The SBIR Program is an incubator for those companies new to Federal procurement. It teaches them how to deal in this arena. If the small business sector were mainstreamed into the Federal procurement process, I daresay we would see an even greater decrease in small business participation in Federal procurement, an irony given the fact that the small business sector is growing and the U.S. Government needs to foster greater competition in the procurement process.

The success so far of the SBIR Program had led to significant accomplishments like those already described at Collaborative Research or those of Verax. Based in Hanover, NH, Verax was a scientific leader in the biotechnology field. Verax was able to keep live cells immobilized on a large scale, continuous basis critically important to production of monoclonal antibodies. This scientific breakthrough had previously not been done by either the universities or the large drug firms.

Verax today has had substantial investments from large industrial firms as a result of the SBIR awards, and they work closely with Dartmouth College, Rutgers University, and the Massachusetts Institute of Technology. The company has grown considerably as well as continuing to make major contributions to the scientific community.

In New England, particularly in Massachusetts along routes 128 and 495 and in southern New Hampshire, we are seeing collaborations, joint ventures, and investments yielding economic developments far beyond what anyone would have predicted two or three decades ago. As a region, New England has attained more SBIR awards than any other region in the country. I find it no coincidence that as a region we enjoy a solid economic base with predicted growth.

This growth is not confined to the areas mentioned above. In places like Hanover, NH, where firms like Verax and Creare are located, and New Haven, CT, have both become hotbeds for small high technology firms. The New Haven Science Park houses 80 small high technology firms. Many of them have received SBIR funding and have worked closely in collaboration with the State of Connecticut, Yale, and the city of New Haven and the Olin Corp.

New England's small business executives know the importance of the program to the region's economy. At a majority of the New England State meetings for the White House Conference on Small Business, New England entrepreneurs wanted the SBIR Program made permanent. In fact, in a majority all of the White House Conference programs to date, a resounding majority. that has been the call.

Some critics have called for restrictions to the number of awards granted to each State or to mandate that each State receive a certain number of awards. But this type of thinking doesn't take into account regional strengths and differences. For example, there is no way any legislation could make Boston the Nation's oil capitol and take it away from Houston.

So, as the SBIR Program develops and companies move from phase 1 to phase 2 and finally into phase 3, we will see even greater success in the area of scientific achievement, increased job generation, and significant product commercialization, all contributing to an overall healthy and stable economy.

The U.S. Commerce Department's Assistant Secretary for Productivity, Technology and Innovation, Dr. Bruce Merrifield, has publicly stated that there has been a significant decline in U.S. initiated technology. In 1970, only 16 years ago, 70 percent of the world's technology base had been initiated in the United States. Ten years later, that percentage had dropped to almost 50 percent. Merrifield has predicted that by the end of this decade, less than 25 percent of all new technologies will be U.S. initiated.

The SBIR Program is one way the United States is combating these startling statistics. With our foreign competitors already incubating certain industries and countries like Great Britain and the Netherlands developing SBIR-like programs, we as a nation must vigorously support the small business sector in its efforts to make our Nation more competitive. Obviously, the program needs and our Nation depends on it to be reauthorized.

Another way to improve the program is to get the participating agencies to take more interest and work harder in the program. There have been some complaints that the time between phase 1 and phase 2 awards is too long. The agencies have the capability to review, award, and fund phase 2 faster than they do now. They just need to work harder to do so.

A big concern we have about the future of the program is the absence of a technical review by the Office of Science and Technology Policy [OSTP]. This review, mandated by law, must be done before the program sunsets in 1988. But while the position of director of OSTP remains vacant, we wonder when this review will take place.

It will be a difficult fight to reauthorize the SBIR. Our opponents are already preparing their strategy. Without a technical review, the fight will be even tougher. If the OSTP can't or won't do the review, then perhaps the General Accounting Office could do it. Another solution would be to have both the OSTP and the GAO provide technical reviews. That way we can be assured of a more objective result.

Senator Rudman, your foresight created this program. You were the risk taker in the beginning who went to bat for the small business sector. You should be proud of the achievements of the program which received high praise from GAO in its report, "Implementing the Small Business Innovation Development Act—The First Two Years," released in October 1985.

The SBIR Program in just a few short years has proven its worth to the Nation. By statistics generated by NSF and other agencies and anecdotal data, SBIR has shown it can foster concrete scientific achievements by small companies. if it can do this in the short run, just imagine what it can accomplish in the marathon of economic development.

[The prepared statement of Mr. Fletcher follows:]

SBANE

SMALLER BUSINESS ASSOCIATION OF NEW ENGLAND, INC.

TESTIMONY OF

William Fletcher
President
Termiflex Corporation
Merrimack, New Hampshire

and

Chairman of the Board
Smaller Business Association of New England (SBANE)
Waltham, Massachusetts

Before the

Subcommittee on Innovation and Technology
U.S. Senate Small Business Committee

Oversight hearing on the
Small Business Innovation Research Act
P.L. 97-219

Monday, March 3, 1986
Merrimack, New Hampshire

Good morning. I'm William Fletcher, founder and president of Termiflex Corporation, based here in Merrimack, New Hampshire. On behalf of the Smaller Business Association of New England (SBANE) of which I'm chairman of the board, and its national affiliate Small Business United (SBU), I'm here today to testify on the benefits and accomplishments of the Small Business Innovation Research Act.

I founded Termiflex in 1973. Today, we employ 51 and design and manufacture hand-held computer control devices. Serving both the private and public sectors, Termiflex, while currently not involved in the SBIR program, is the type of small business that is participating in this worthwhile government program.

Senator Rudman, you should be proud of the accomplishments of the SBIR program. You believed, if small business was given the opportunity, that they would make significant scientific achievements. And you put this belief into action by leading the fight to pass this landmark legislation. I'm pleased to report that unlike a lot of legislation, this law is working.

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2) to target that support towards development of technology.

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Clearly, the SBIR program has accomplished its first objective. It's too early in the program's implementation to show any meaningful statistics of scientific developments that have emerged are now being commercialized because of SBIR. However, there is plenty of anecdotal evidence that makes us confident that SBIR will foster not only the development of an idea, but lead to commercialization of those ideas as well.

One good example of successful collaboration which has led to commercialization is the activities of Collaborative Research in Lexington, Massachusetts. This small company, which began with 33 employees, received its initial award from the National Science Foundation (NSF) for genetic research. This was four years prior to the Supreme Court's decision to allow the patenting of genetic combinations. Their Phase I award was $25,000 in 1977, and for Phase II, they received $240,000. This initial government investment of $265,000 led to $42 million invested by Dow Chemical and two public offerings. The company has grown from 33 employees to 135. Collaborative Research now has new laboratories and such scientific contributions to its credit as the major identification of the genetic marker which first indicated the presence of cystic fibrosis.

This is the type of accomplishment, in terms of scientific contributions, job generation and leveraged private/public sector dollars, that has led to significant economic development in New England as well as other parts of the nation.

I'm confident that as the SBIR program matures, we will see more accomplishments like this one. In fact, to judge fairly the program, the experiences of the NSF program should be examined closely since they have been in this activity much longer than other government agencies.

It takes seven to eight years, and in some fields longer, to bring an idea to the marketplace. With the SBIR program only three years old, these is much excitement at the developments that will occur within the next few years based on scientific breakthroughs achieved SBIR companies have in just three short years.

So you see, those who initially opposed the proposed legislation based on doubt that there weren't many small business R&D outfits out there who would qualify or participate in the program, have been resoundingly proven wrong.

The same holds true for the federal agencies who were concerned about receiving quality proposals. Today, most, if not all, would testify that the quality of proposals in most cases is equal to other applied research and development propsoals that they receive from any source.

Scientific development, job generation, economic development, technology transfer and commercialization will be the rule not the exception to the SBIR program. By using NSF experiences, we prove our point. Of the early NSF awards made between 1977-1981, total follow-on funding from private sources of which most were investments, now exceeds $150 million compared to NSF expenditures for that period of $16 million. This is an astounding 9 to 1 ratio of private sector leverage over the government R&D investment.

While programs in the Department of Defense and some other agencies may require some follow-on funding from the agency itself in terms of production contracts, the NSF results show what can be done in terms of stimulating private sector investments by the early funding of advanced research for R&D ideas.

But let's examine some of the changes we see happening to the program in terms of support in the small business community and the program's contribution to the health of the New England economy.

More and more larger small firms are participating in the SBIR program now. While there is a place for the one or two person R&D contract shop, the attention and participation of the larger small firms is a good sign of the program's increasing credibility within the small business sector. These larger small firms have recognized that the SBIR program is worth the investment of their time and money to compete for the awards. And many of them, viable companies without SBIR, look to the program as a certificate of technical competency. The rigorous procedures and close examinations that a company must go through before receiving an award is enormous. But if that company is granted an award, that company has gained verifiable proof of its technical competence. Receipt of an SBIR award has enabled many companies to raise money from private sources, which in turn leverages the government's money.

We are also seeing a change in the type of company participating in the program. A greater number of problem solving, engineering-oriented companies are now applying for and receiving SBIR awards. This movement away from the R&D contract shop is positive. Since the engineering-oriented firms are generally more successful in their ability to target their efforts to carefully match their expertise with proposals. This usually leads to better proposals and greater success with the development of an idea. In the later stages, particularly in pursuit of commercialization and technology transfer, these problem solving oriented companies can respond better and faster to market conditions.

Many small R&D start up companies have successfully used the SBIR program to make the transition to a company that not only develops an idea, but designs systems and manufactures and markets them as well. Those firms have successfully used the SBIR program to bootstrap themselves into a growth mode. Even the small R&D contract shop that chooses to remain small, often participates with larger companies to commercialize their ideas.

So while the complexion of the companies involved in SBIR has changed, there is still a mix. But to think that companies in the SBIR program are surviving only because of federal dollars is incorrect. Whether it's a two person R&D shop or a 75 person manufacturing company, the program has enhanced each company's scientific and business efforts.

SBIR critics like to point to multiple award winners as living off the program or taking it over. Some have suggested that a cap be put on companies to prevent any one company from receiving too many awards. Impressions aside, multiple winners represent a small percentage of the total SBIR recipients. If those companies submit good proposals, why should the government disqualify them from the program. The cap on qualified SBIR companies is as ridiculous as if our federal forefathers limited Edison to only six inventions.

There is much excitement in the small business community about the SBIR program. This is evidenced in the fact that more and more new companies are getting involved in the program. For FY 1985, over 55 percent of the companies receiving awards were new to the SBIR program. More astounding is the fact that for the FY 83 Phase I award recipients, 80 percent of them had no prior experience in federal procurement arena whatsoever. This involvement is being expanded into the general procurement arena, thanks to the SBIR program. Many project managers becoming familiar with small companies through the SBIR program are now awarding contracts to those qualified companies for work outside the SBIR program.

Critics of SBIR would argue that this positive trend is reason enough to eliminate the SBIR program and mainstream small companies into the government procurement process. But this positive trend is misleading. According to The State of Small Business: A Report of the President, May 1985, the small business share of total government procurement declined both as a percentage of the total purchases of goods and services and in absolute dollar volume in FY 1983. The report also notes that the dollar volume of prime contract awards to small firms in the R&D area, grew 20 percent from FY 1979 to FY 1983, while the total sector grew 70 percent. Thus, the small firm share decreased by nearly two percentage points.

The SBIR program is an incubator for those companies new to federal procurement. It teaches them how to deal in this arena. If the small business sector was mainstreamed into the federal procurement process, I daresay we would see an even greater decrease in small business participation in federal procurement --an irony given the fact that the small business sector is growing and the US government needs to foster greater competition in the procurement process.

Access to resources is another result of the SBIR program. While developing an idea under the SBIR program, the small company is gaining verifiable credibility in the business community. This opens the doors to collaborative efforts and joint ventures with other small companies, big businesses or universities. Some small firms are even working with multiple partners.

This exciting development has lead to significant accomplishments like those already described with Collaborative Research or those of Verax.

Based in Hanover, New Hampshire, Verax was a scientific leader in in the biotechnology field. Verax was able to keep alive cells immobolized on a large scale, continuous basis critically important to production of monocolonal antibodies. This scientific breakthrough had previously not been done by either the universities or the large drug firms. Verax today has had substantial investments from large industrial firms as a result of the SBIR awards and they work closely with Dartmouth College, Rutgers University, and the Massachusetts Institute of Technology. The company has grown considerably, as well as continuing to make major contributions to the scientific community.

Whether a small firm chooses to stay small and teams up with a larger company already geared up for the manufacturing process or receives private sector investments and commercializes the idea itself, the point is that economic development is occurring on a wide scale thanks to the SBIR program.

New England, particularly in Massachusetts along Routes 128 and 495, and in southern New Hampshire, we are seeing collaborations, joint ventures and investments yielding economic developments far beyond what anyone could have predicted two or three decades ago. As a region, New England has attained more SBIR awards than any other region in the country. I find it no coincidence that as a region we enjoy a solid economic base with predicted growth.

And this growth is not confined to the areas mentioned above. In places like Hanover, New Hampshire, where firms like Verax and Creare, Inc., are located, and New Haven, Connecticut have both become hotbeds for small high technology firms. The New Haven Science Park houses 80 small high technology firms. Many of them have received SBIR funding and have worked closely in collaboration with the State of Connecticut, Yale, the City of New Haven and the Olin Corporation.

Dr. James Howell, senior vice president and chief economist at the Bank of Boston, attributes New England's astounding economic turnaround via the high technology sector to three ingredients: a supply of investment or "risk" capital; a relatively large pool of skilled labors; and the presence of entrepreneurs.

Indeed, the New England region has made a dramatic turnaround since the mid-seventies. Since 1975, the New England economy has generated more than a quarter of a million new manufacturing jobs and its unemployment rate remains well below the national average.

According to a study by Bank of Boston, between 1975-1980, young high-tech companies were creating jobs at a rate of 24 percent. In a speech to the Security Analysts Association of Japan, Dr. Howell explained, "New England's economic strength -- especially as seen in the high-technology industries -- demonostrates persuasively that regional growth can be led by manufacturing if industry is technically innovative and government policy responsive." (See attachments.)

In this same speech, Dr. Howell pointed out that New England clearly benefits more than any other region from federally-sponsored research and Department of Defense contracts: with only five precent of the US population, New England receives more than 10 percent of federal research and development funds and 11 percent of federal defense contracts awarded.

New England's small business executives know the importance of the program to the region's economy. At a majority of the New England state meetings for the White House Conference on

Small Business, New England entrepreneurs wanted the SBIR program made permanent.

Across the nation the states have recognized the importance of SBIR to their efforts in economic development. Statistics have shown that there is a direct correlation between states that foster an environment condusive to small high technology firms and those who receive the awards.

Some states like New York and Pennslyvania provide grants to their SBIR award recipients to further enhance the incubation process. These same states also provide intensive training for the small companies to help them apply for grants and administer the program once they receive a grant. We are seeing small companies located in such unlikely high technology states as Utah and Arizona, winning awards as a result of those state's efforts. And likewise, we're seeing some state's loosing ground to the increased competition by the other states.

This competition is healthy. In the sixties and seventies, economic development often meant luring companies away from one state and to another. Today, the states recognize that fostering home grown companies is the only permanent way to successful economic development.

Some critics have called for some type of restrictions to the number of awards granted to each state or to mandate that each state receive a certain number of awards. But this type of thinking doesn't take into account regional strengths and differences. For example, there's no way any legislation could make Boston the nation's oil capital and take it away from

Houston.

So as the SBIR program develops and companies move from Phase I to Phase II and finally into Phase III, we will see even greater success in the area of scientific achievement, increased job generation and significant product commercialization --all contributing to an overall healthy and stable economy;'

One study after another has proven that small business has the ability to create a disproportionate number of major innovations and jobs compared to large firms. An NSF study shows that small firms with 100 or less employees contribute six times the number of innovations per dollar of R&D expenditures compared to large firms with 4000 or more employees.

This astounding finding is magnified when one remembers that small firms receive a little less that 3 percent of total federal R&D dollars (SBIR and other programs combined). That's tragic.

D. Bruce Merrifield, currently the assistant secretary for productivity, technology and innovation in the US Department of Commerce has publicly stated that there has been a significant decline in US initiated technology. In 1970, only 16 years ago, 70 percent of the world's technology base had been initiated in the United States. Ten years later, that percentage had dropped to almost 50 percent. Merrifield has predicted that by the end of this decade, less than 25 percent of all new technologies will be US initiated.

The SBIR program is one way the US is combatting these startling statistics. With our foreign competitors already incubating certain industries,and countries like Great Britian and the Netherlands developing SBIR-like programs, we as a nation must vigorously support the small business sector in its efforts to make our nation more competitive. Obviously, the program needs -- our nation depends on it -- to be reauthorized.

To improve the program, I'd suggest an increase in the set aside percentage for some agencies. While some proponents of the program advocate an across-the-board percentage increase, this is not appropriate given the great difference in dollar volumes from agency to agency. While some agencies, particularly the larger ones, appear to be making as many SBIR awards as they can, there are others who could increase their participation. We recommend that the government increase the percentage of awards based on the total size of the R&D budget for each agency. This could be handled by setting up different percentage brackets.

Another way to improve the program is to get the participating agencies to take more interest and work harder in the program. There has been some complaints that the time between Phase I and Phase II awards is too long. The agencies have the capability to review, award and fund Phase II faster they they do now, they just need to work harder to do so.

A big concern we have about the future of the program is the absence of a technical review by the Office of Science and Technology Policy (OSTP).

This review, mandated by law, must be done before the program sunsets in 1988. But while the position of director of OSTP remains vacant, we wonder when this review will take place. OSTP has not come out and said whether they're going to perform the review or not. And if they are going to do it, the review should begin in the summer of 1986, after the first class of Phase II award winners graduate. This time frame would also generate results for the reauthorization hearings that will most likely take place in the summer of 1987.

It will be a difficult fight to reauthorize the SBIR. Our opponents are already preparing their strategy. Without a technical review, the fight will be even tougher. If the OSTP can't or won't do the review, then perhaps the General Accounting Office could do it. Another solution would be to have both OSTP and the GAO provide technical reviews, that way we can be assured of objective results.

Senator Rudman, your foresight created this program. You were the risk-taker who went to bat for the small business sector. You should be proud of the achievements of the program, which received high praise from GAO in its report, "Implementing the Small Business Innovation Development Act -- The First Two Years", released in October 1985.

The SBIR program in just a few short years has proven its worth to the nation. By statistics generated by NSF and other agencies and anecdotal data, SBIR has shown it can foster concrete scientific achievements by small companies. If it can do this in the short run, just imagine what it can accomplish in the marathon of economic development.

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BANK OF BOSTON

Remarks by Dr. James M. Howell
Senior Vice President and Chief Economist
Bank of Boston
The Role of High Technology in the U.S. Economy:
The New England Experience
Before The Security Analysts Association of Japan
February 20, 1984
Tokyo

Introductory Comments

One of the great challenges facing industrial economies is the ability to evolve new industries as traditional industries face increased competition from lower-wage countries. History has shown that this process of technological innovation and adaptation is the key to continued economic growth. It is a complex process involving a combination of risk capital, skilled labor, and entrepreneurs.

The New England experience has gained worldwide attention as an example of successful technological adaptation and manufacturing revitalization. My remarks today will focus on the New England experience and its relevance for regions -- or countries -- seeking to transform their manufacturing base in the face of increasing international competition.

Throughout much of the 1970s, economic observers, ourselves included, were openly pessimistic about New England's future, largely because of the region's poor economic performance in the 1969-70 -- and especially the 1974-75 -- recessions. More recently, we have come to fully appreciate the meaning of the maxim: "The only thing certain about the future is change."

Looking backward at the events of these years from the vantage of 1984, it is clear that the structure of New England's economy has undergone a fundamental change. Relative to the first half of the 1970s, manufacturing has swung abruptly from a laggard in overall regional growth (down 5.6 percent) to the second sharpest growth sector (up 4.4 percent), as shown in Table I. Indeed, approximately one-fourth of the region's employment growth in the second period can be explained by the improved performance in manufacturing.

TABLE I

	1968-75	1975-80
Percent Change in New England Nonagricultural Employment	+5.2%	+17.5%
Relative Sectoral Contribution:		
Construction	-0.5%	+0.3%
Manufacturing	-5.6	+4.4
Trade	+3.0	+3.7
Services	+5.2	+7.3
Government	+3.1	+1.8

That manufacturing activity would demonstrate such economic vitality in the oldest industrialised region of our country is most interesting. It tends to provide clear refutation to those who have argued that older regions must necessarily be condemned to a future of slow economic growth, or even stagnation, as a result of a failing manufacturing base. New England's economic strength -- especially as seen in the high-technology industries -- demonstrates persuasively that regional growth can be led by manufacturing if industry is technologically innovative and government policy responsive. ✓

The results are, indeed, impressive. Since 1975 the New England economy has generated more than a quarter of a million new manufacturing jobs. The region's unemployment rate -- at 5.9 percent -- remains well below the national average of 8.2 percent, and Massachusetts continues to have the lowest unemployment rate of any industrial state in the nation. Moreover, many older communities in the region have been able to reverse their declining economic fortunes.

New England's resurgence has been noted by such publications as The New York Times, The London Economist, and The Wall Street Journal. The analysis in all of these respected papers points clearly to a dramatic "Yankee Turnabout" in the New England economy -- but few observers have been able to explain clearly why this has occurred.

In my remarks today I want to attempt to provide an answer, or answers, as to: Why New England? In response to this question, I will cover three important issues:

- The evolution of New England's technology base.
- The underlying fundamentals of the region's production process.
- The perception of the region as a place of opportunity.

The Evolution of New England's Technology Base: The Process of Hurrying History Along

Of all the factors affecting this region's economic turnabout, the spectacular growth in high-technology industries clearly stands out.* Attempts to trace developments leading to the revitalization of the region generally assume that the technology base of New England emerged somewhere in the post-Sputnik-NASA era of the 1960's. There is much to be said about the technical dynamism of this period and its relationship to the revitalization. To be sure, New England continues to benefit more than other regions from Federally-sponsored research and Department of Defense contracts: with only five percent of the U. S. population, New England receives more than 10 percent of Federal research and development funds and 11 percent of Federal defense contracts awarded.* Nonetheless, the reality is that New England has always been on the cutting edge of technology.

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*In the past, there was a tendency to equate the term "high technology" with a very narrow spectrum of enterprises, primarily firms producing computers and semi-conductors. Increasingly, however, high tech has come to be viewed as encompassing a wide array of advanced technology industries, including health care, communications systems, pharmaceuticals, publishing and scientific instruments. Even more broadly, high tech industries can be viewed as knowledge-intensive manufacturing industries actively engaged in developing new products and processes.

Let me briefly elaborate this point. The factors underlying the birth of the American Industrial Revolution in New England in the early 19th century are the very same ones that account for the success of high technology today:

- o A supply of investment or "risk" capital. In years past this was made available from overseas trade; today much of it comes from the profits of successful technology start-ups.
- o A relatively large pool of skilled labor. One hundred and fifty years ago -- as today -- the region could boast of more skilled craftsmen and mechanics in the traditional industries than other parts of the country.
- o The presence of entrepreneurs who have understood the demands of risky investments and have effectively drawn upon capital and skilled labor in transforming innovations into profitable production.

In the early 19th century the commingling of these critical ingredients led to the high concentration of technical development in New England -- creating entirely new markets and industries, such as machine tools and textiles.

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*The principal small firm beneficiaries of government R & D have been in the electronics industry, where much early military R & D went toward unproven technologies that have since found broad commercial application.

These, in turn, produced many new industrial spinoffs. In fact, a large number of today's leading high tech firms in the region owe much of their advantage to firms which came before them. To cite just one example, the robotics industry of today came out of a long line of New England machine tool development that can be traced back to the early 19th century.*

Development planners from other parts of the United States as well as overseas countries have sent representatives to New England to study the "spinoff" process. The lesson they invariably take home is that it takes a variety of resources to produce technological growth. As I mentioned earlier, skilled workers, capital, and entrepreneurs are a must. But the glue that holds this together is the presence of preeminent educational institutions.

In June 1982 a study on high technology carried out by the Joint Economic Committee of the U. S. Congress concluded the following:

> ...unlike the more traditional manufacturing companies, high technology companies...seek out a community noted for the excellence of its academic institutions...universities provide benefits to high technology companies through their basic research activities and through the intellectual and cultural climate that they provide. More important... universities provide skilled labor in the form of faculty consultants, research assistants, and graduating students.

In addition to these benefits, a number of universities are setting up "incubator" facilities that provide low cost space for start-up companies technical and management assistance, as well as laboratory, library, computing, and office service facilities.**

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*This line of reasoning is drawn from "The Evolution of New England Industry," New England Economic Review, March/April, 1981.

**See "Universities Emerge As an Important Catalyst in the new Business Development Process," The Venture Capital Journal, August, 1983.

New England has powerful advantages with respect to its institutions of higher education. With 260 colleges and universities -- 65 in the Greater Boston area alone -- New England is the most knowledge-intensive region of the country and the world. Approximately 800,000 are students enrolled in New England colleges and universities, and many of them stay in the region after graduating -- heading out into high technology and information industries or the professional services market.

Historically, the Massachusetts Institute of Technology (MIT) has played a critical role in research which furthered the development of industrial products and processes. But MIT is not alone or unique in this regard. In central Massachusetts, Worcester Polytechnic Institute -- and in Rhode Island, Brown University -- have played a role similar to that of MIT in providing engineering input to innovative companies. In reality, it is the total environment of universities and technology-based industries together making new products and processes in fields of common effort which has provided the basis for the region's economic turnaround.

Yet no region or country, even New England, can maintain technological excellence without some periods of discontinuity. In New England there have been relatively long periods -- roughly 25 years -- between the maturing of one technology with its broad income and employment benefits, and the next. In New England's case, the first was the 19th century Industrial Revolution, the second was the technology of World War II and currently, the computer revolution. The movement from one period to the next, however, was most uneven, involving industry dislocation and high structural unemployment.

But however harsh these adjustments have been economically, I am convinced that the educational and technological superiority of New England has greatly facilitated the region's capacity to "hurry history along" in the transition from one period to the next. For other less educationally and technically well-endowed regions of the U.S. this adjustment process may well be even more difficult.

The Underlying Fundamentals of the Region's Production Process

I would like to turn now to the underlying fundamentals that have contributed to the recent rebirth in the region's technologically-based manufacturing sector. Admittedly, these factors have long enabled the region to "hurry history along" in adjusting from one technological era to the next, but they can be most easily observed in the current period of technological transition.

Factor #1: The Role of Aggressive Venture Capital and Commercial Banking in The Region

As I suggested earlier, throughout U. S. history, New England has provided leadership in developing new ways of providing investment in a dynamic economy. Indeed, taking investment risks has been a habit in New England since the days of the East India trade. As a result, the region has an unusually large number and variety of financial institutions.

Venture capital is a major source of financing for industrial enterprises. For high tech firms, venture capital, or start-up money, can transform good ideas into saleable products. Perhaps not surprisingly, one of the sources of this venture capital is entrepreneurs who have built successful high tech firms and now choose to channel their own capital resources into new technology starts. For instance, the Boston-based seed capital fund -- Eastech -- was created with the financial participation of over 100 such individuals.

Geographically, the lion's share of venture capital dollars in the U.S. has been concentrated in California and Massachusetts. During the 1970s, Massachusetts alone -- with only 2.5 percent of the U. S. population -- accounted for roughly 25 percent of all the venture capital investments in the nation. Since 1981, two New England states -- Connecticut and New Hampshire -- are among the states that have substantial new venture capital investment.

But venture capital provides only part of the financing for high-tech firms. At the proper stage of development, banks have helped put together the overall financing packages that have allowed "coming" companies to become "going" concerns.

Bank of Boston's commitment to high tech took an interesting form in the late 1960s. At that time any entrepreneur with a Federal contract in hand found it extremely easy to obtain credit at the Bank, and thus Route 128 -- known as America's high technology highway -- became a reality. This kind of aggressive commercial bank lending to high tech firms in the region is even more commonplace today.

Factor #2: The Role of State Policies

Before the recession of 1974-75, the region's left-of-center political focus was more on redistributing rather than on creating wealth. But the sinking economic conditions of the mid-1970's coupled with a fast-rising challenge from competitive Sunbelt states, jarred New England out of its "Yankee" reserve.

From Maine to Connecticut the tax-and-spend attitude of state governments in the region that prevailed during the 1960s and early 70s has given way to a recognition that economic health depends on jobs and job creation depends on a favorable business and tax climate. Anyone driving through New England can easily see this change in attitude in state advertising posters, bumper stickers, and television commercials -- a "good neighbor" policy for business has become a reality.

But the real proof lies beneath the surface -- in the changes in state policies which have helped state officials throughout New England put out the welcome mat for business, particularly technology-based firms:

- o An extensive network of development finance entities has been created to assist business start-ups and expansions with capital and technical assistance. The Massachusetts Technology Development Corporation, for example, is a public agency which provides venture capital to early-stage high-risk technology companies in the state.
- o States in New England have been among the first in the nation to centralize business-related programs by establishing a "one-stop shopping center" in the state government for business seeking information on site location, permitting requirements, and state incentive programs.
- o New England states have launched major new programs for customized job training to ensure that high tech's employee skill needs are met.

While it would be naive to argue that all elected officials in New England have become "born-again capitalists," there has been a dramatic shift in attitudes among elected leaders since 1975 -- unquestionably contributing to the region's technology-based revitalization.

Factor #3: The Role of Manufacturing Production Costs

The revitalization of New England manufacturing has also come about in part because of the regional equalization of production costs. In a recent milestone study Dr. Ben Stevens demonstrated that the New England economy has become relatively more competitive for manufacturing. Specifically, this analysis shows that during the 1973-80 period there has been a relative production cost improvement in New England vis-a-vis the Old South states that ranges from 30-50 percent.* The positive adjustment of wages has dominated this change to the point that today New England now has the lowest real wages of all regions in the country. The relevant wage data ratios are shown in the following table.

TABLE II

Average Regional Manufacturing Wages as Percent of New England
1980

New England	100%
Great Lakes	114%
New South	104
West Coast	136

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*Benjamin H. Stevens, "Regional Cost Equalization and the Potential for Manufacturing Recovery in the Industrial North", unpublished papers presented at a conference sponsored by the State University of New York at Albany, April 1982.

These data confirm that New England enjoys a competitive wage scale, even when judged against our strongest regional rival — the New South. The low wage rates in New England are particularly important to high tech industries which are far more labor-intensive than manufacturing industries as a whole.* The attractiveness of New England's labor force is further enhanced by the virtual absence of unionization within the high tech industries.

In the final analysis, just as the presence of first-rate educational facilities is critical to technology start-ups, so labor availability and wage rates dominate the expansion needs of high tech firms. Here, as with its institutions of higher learning, the region currently stands on firm ground.

However, a cautionary note is in order. Over the long term "tight" labor markets are likely to develop as defense contractors and high tech firms vie for skilled and semi-skilled labor. Looking ahead, the issue of labor

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*Empirical analyses undertaken by Bank of Boston's economists have shown that the production processes of high technology firms are heavily labor intensive. This can be most easily seen when one examines the capital investment (for plant and equipment) required to create each job in overall manufacturing and the comparative capital spending figures for high technology manufacturing during the critical years of accelerated revitalization in New England.

Capital Investment Per Worker Entering the Labor Force
1975 - 1980

United States Economy	Cost per Job (in Thousands)
All Manufacturing	$243.8
New England Region	
All Manufacturing	$ 70.7
High Technology Industries	33.8

availability is likely to become an especially pressing factor in new business growth and a concern for regional policymakers, as labor scarcity pushes wages upward and a new cycle of competition for workers is set into motion.

The Perception of the Region as a Place of Opportunity

Ralph Waldo Emerson once asked, "Why should not the New Englander try new adventures?" He could have been speaking of the researcher who sees a promising but risky path and pursues it even if it is at odds with conventional thinking or the entrepreneur who can capitalize on new product ideas in the face of difficulties, or the financier who is willing to back the exciting but uncertain proposal.*

Along these lines, Frank Newman, former president of the University of Rhode Island, has remarked that what distinguishes New England from other parts of the country is the presence of an "opportunistic" environment that favors innovation and which, in turn, attracts "risk lovers" -- the very kind of individual who is most likely to beat the odds, pursue an idea with tenacity and determination, and become a successful entrepreneur. This is also precisely the kind of environment in which technological breakthroughs occur, generating entirely new products and services.

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*Seymour Lipset notes that it is the fabric of social, educational and cultural factors that produces a steady stream of entrepreneurial behavior. He also reminds us that such factors are not easily replicated. (Elites in Latin America, New York, Oxford University Press, 1967)

In the eyes of would-be entrepreneurs New England *is* a good place to start a business -- and it is a particularly good place to start a technology-based business. Start-ups are likely to be more concentrated in existing high tech centers because they often draw upon the labor and entrepreneurial resources of established firms. As Dr. Lynn E. Browne, Vice President of the Boston Federal Reserve Bank, pointed out in a recent article,

> "High tech firm after high tech firm has been started by individuals previously associated with other high technological companies. In many cases the new operation is almost next door to the old. The computer industry provides some striking examples. . . In Massachusetts, Data General was founded by a former Digital employee. Apollo Computer was started by former executives of Prime Computer and, very recently, the former president of Prime announced the formation of Encore Computer Corp. Existing high tech firms are both training grounds and hotbeds of ideas. They also provide examples of entrepreneurial success which excite the ambitions of their employees."*

I have already discussed the historical importance of labor, capital, and entrepreneurs as well as the presence of educational institutions in making the region technology-supportive. We have seen the roles played by aggressive financiers, changes in state policy and declining relative wage rates in New England's most recent period of technological vitality. One may still ask, however, to what extent these factors remain important as high tech firms "grow up."

Robert M. Ady, Executive Vice President of the Fantus Company, recently provided an answer based on the different growth stages of high tech companies.

Stage #1: "The entrepreneurs are usually scientists or theoreticians, not necessarily practical business people. They need ... cross-fertilization of

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*See Lynn E. Brown, "Can High Tech Save the Great Lakes States," *New England Economic Review*," November, December, pp. 23-24.

talent and ideas from other high-tech companies in the area ...* The company may be near a university setting so individuals working on a project can retain close relationships with the university, the professors, colleagues, and facilities...Commercial air service is also important. Entrepreneurs spend a significant amount of time talking with other people working on similar ideas all over the country."

Stage #2: "Locational characteristics are different once the product has viability and is accepted in the marketplace. The availability of skilled labor and vocational/technical schools becomes a critical factor...At this stage the company has a saleable product, is still very technical, and needs accessibility to the R & D facility -- the theoretical base. A 'magic mileage' formula is usually used here -- within 300 to 400 miles of the location of R & D or within two to three hours of travel."

Stage #3: "Price competition enters seriously into the product at this stage. Labor and transportation costs become most important as the new product becomes copied by other firms."

Based on these locational requirements, many New England communities are particularly attractive sites for Stages 1 and 2 in the growth of high tech firms. Moreover, it is during these very stages that high tech firms have the highest rates of job-generation.

A study undertaken by the Bank's Economics Department, based on earlier analyses of the MIT Development Foundation, shows that the employment growth rate is particularly significant in the early growth stages of high tech firms, but diminishes as the companies mature. The following tables clearly tell the story.

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*The process described here is technically known as agglomeration; that is, the clustering of a support network of companies to exploit market opportunities. Agglomeration and spin-offs are mutually-reinforcing. The creation of new firms increases further corporate activity, reinforcing the comparative technological advantages of the area.

MATURE COMPANIES

Average Annual Growth (Compounded)

1965-1974

	Sales	Jobs
Bethlehem Steel	4.9%	-1.7%
DuPont	8.6%	2.6%
General Electric	8.4%	3.5%
General Foods	8.2%	4.5%
International Paper	9.2%	2.8%
Procter & Gamble	9.6%	3.8%
Weighted Average	7.8%	1.9%

INNOVATIVE COMPANIES

Average Annual Growth (Compounded)

1945-1974

	Sales	Jobs
Polaroid	14.0%	9.0%
3M	14.1%	9.0%
IBM	16.8%	10.2%
Xerox	24.2%	19.4%
Texas Instruments (1953-1974)	21.2%	17.3%
Weighted Average	16.5%	10.8%

YOUNG HIGH-TECHNOLOGY COMPANIES

Average Annual Growth (Compounded)

1969-1974

Date Incorporated		Sales	Jobs
1968	Data General	140.5%	82.5%
1959	National Semiconductor	54.3%	59.4%
1960	Compugraphic	50.2%	24.0%
1957	Digital Equipment	36.8%	30.7%
1964	Marion Labs	24.5%	25.4%
	Weighted Average	42.5%	40.7%

MATURE COMPANIES

Average Annual Growth (Compounded)

1975-1980

	Sales	Jobs
Bethlehem Steel	6.3%	-5.3%
DuPont	13.7%	0.5%
General Electric	12.1%	1.4%
General Foods	10.7%	2.4%
International Paper	11.2%	-8.0%
Procter & Gamble	12.1%	2.8%
Sales-Weighted Average	11.5%	0.0%

INNOVATIVE COMPANIES

Average Annual Growth (Compounded)

1975-1980

	Sales	Jobs
Polaroid	12.3%	5.5%
3M	14.2%	0.8%
IBM	12.7%	3.4%
Xerox	15.1%	5.2%
Texas Instruments (1953-1974)	24.4%	9.7%
Sales-Weighted Average	14.4%	4.3%

YOUNG HIGH-TECHNOLOGY COMPANIES

Average Annual Growth (Compounded)

1975-1980

Date Incorporated		Sales	Jobs
1968	Data General	40.4%	34.3%
1959	National Semiconductor	31.4%	21.4%
1960	Compugraphic	30.2%	18.1%
1957	Digital Equipment	34.7%	23.9%
	Sales-Weighted Average	34.6%	24.0%

The first three tables show the job creation growth rates from 1945 to 1974 for mature companies, innovative companies, and young high tech companies. (the young companies from 1969-74). It is interesting to note that while jobs at mature companies increased at a rate of 1.9 percent, they increased at 10.8 percent for innovative companies and a remarkable 40.7 percent for young high tech companies. Admittedly, part of this phenomenon can be explained by "statistical smallness" in the high tech companies, but the increases are maintained for such a sustained period of time that they cannot be dismissed.

During the 1975-1980 period, these job creation rates slowed for all three categories. However, young high-tech companies were still creating jobs at 24 percent --a healthy job growth rate but a 40 percent decline from the earlier period.

The lesson here is that high tech companies are in a state of dynamic growth and adjustment. Today's high tech industries will undoubtedly fade -- being supplanted by new technologies and a slowdown in job creation as a result of maturation. Sustained growth only comes to those regions that encourage a willingness to continually shed the old to make room for the new.

Growing up in West Texas, I saw rattlesnakes shed or slough off their skins to give themselves "wiggle room" for new growth. Since becoming a New Englander, I have seen my region do the same: shed an outworn technology to make room for new ones. Emulating the rattlesnakes can help a region -- as it has New England -- to "hurry history along" in the transition from one technological era to the next.

Will It Happen Elsewhere?

In the U. S. today the competition among states for "high tech" industries is fierce. State after state is actively engaged in targeting specific high-tech industries and in designing aggressive marketing campaigns for these industries.

Along these lines, there has been some specialization among areas with respect to "niches" of high technology. For example, within the computer field alone, the Silicon Valley, South of San Francisco, is the heart of the semiconductor industry, while New York City excels in applications software, Minneapolis, Minnesota in supercomputers, Atlanta, Georgia in computer time-sharing, Boston, Massachusetts in minicomputers, and Austin, Texas in electronic components and small computers.

All of these areas have in common, in varying degrees, the high tech prerequisites of entrepreneurs, capital, skilled labor, and a favorable university/industrial climate. For other areas in the U. S. and overseas -- especially those that do not have strong higher educational institutions -- the success in pursuing high tech may well lie not in creating or spawning high tech companies, but in trying to become an attractive location for high tech assembly-line branch plants -- the Stage #3 I referred to earlier in my remarks.*

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*Many areas in the U.S. South -- dominated by branch plant production and low-skill manufacturing, and having little R & D activity -- have provided "comfortable homes" for the computer industry.

The New England Experience: Lessons for the U. S.

While high tech jobs will grow more rapidly than employment in the economy as a whole during the 1980s, the absolute number of new high tech jobs will be small compared to the number created in the non-manufacturing sectors. Nonetheless, high technology will remain especially important to the U. S. in keeping the nation's economy competitive in world markets.

The cornerstone role played by high tech industries in the economy has led some to conclude that the U. S. needs a national industrial policy. One of the major aims of such a policy is to make the U. S. economy more industrially productive and aggressive, largely by targeting and assisting industries -- sometimes called "sunrise" industries -- that appear likely to become the technological pioneers of the future, achieving fast growth, large employment, and strong export performance.

Many of the ideas that are discussed as part of a national industrial policy -- greater government-business-labor cooperation, more government assistance to education and job training, and a national industrial financing bank -- are certain to be widely debated during this year's American elections. While the idea of a national industrial financing bank to help older "sunset" industries as well as newer "sunrise" high tech industries is especially controversial, nearly all the Democratic presidential hopefuls have embraced the concept of a national industrial policy in one form or another. In so doing, they point to the legendary success of Japan's Ministry of International Trade and Industry (MITI), arguing that behind Japan's success is a strategy of targeting industries presumed to represent the wave of the future, accelerating their progress with government support and early protection in the domestic market, and then helping them to succeed in external markets.

Others believe that the Japanese use of an industrial policy has been oversold. For example, Charles L. Schultze, who served as Chairman of the Council of Economic Advisers in the Carter Administration, contends that Japan's big advantage in technological success is its very high rate of savings and investment -- 30 to 35 percent of Japan's gross national product compared with 17 to 19 percent in the U.S., according to the O.E.C.D.

I might emphasize here that the debate over a national industrial policy in the U.S. is an issue which could have a profound effect on the future of Asian exports in U.S. markets. While most proposals emphasize the dynamic aspect of promoting new industries, an activist U.S. government policy might entail sustained protection of some industries with large employment in order to promote a gradual restructuring of these industries. Thus, access to the American market from highly competitive industries in Asia, such as steel, cars, and consumer electronics, could be curtailed during this transition period. At the high end of the technology spectrum an activitist U.S. industrial policy might include protection of new industries from premature foreign competition, most likely from Japan.

The Reagan Administration, on broader grounds, strongly opposes a national industrial policy in any form, maintaining that government planning and subsidies are not only useless but actually harmful and that the marketplace -- not government -- should be picking "winners and losers" among industries. Instead of a national industrial policy, the Administration believes the Federal government can enhance the international competitiveness of U. S. products by increasing the rate of capital formation in the U.S., (largely through changes in the tax laws), reducing the regulatory burden, and fostering research and development through tax credits and the elimination of antitrust barriers -- thereby allowing American companies to compete in R & D to meet the challenge of foreign competition.

I personally believe that the U. S. response to foreign competition does not lie in a national industrial policy. It does lie in national revitalization along the lines of the New England experience coupled with an attempt to squarely address the Federal budget deficit.

Let me briefly elaborate this point. The persistent U.S. Federal budget deficits have resulted in sustained high U.S. dollar rates, which in turn have produced an overvalued dollar. The high value of the dollar has led to increasing support for protectionism in the U.S. It is easy to misread this situation and assume that a national industrial policy would help U.S. manufacturers compete. In reality, if we had a more competitively valued dollar, the interest in a national industrial policy would surely fade.

Concluding Comments

New England's economic revitalization over the past decade demonstrates persuasively that regional growth can be led by manufacturing if industry is technologically innovative. And while a number of factors have played a major role in producing these results -- risk capital, skilled labor, aggressive entrepreneurship -- the presence of preeminent educational institutions has been especially important. ✓

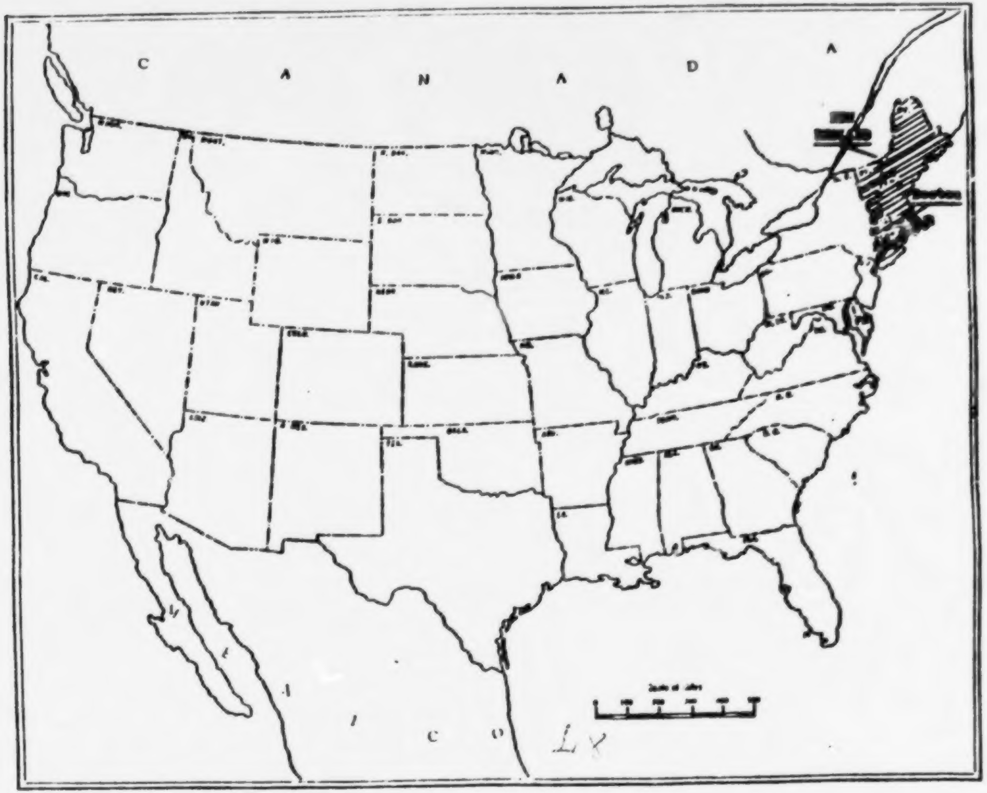
However, looking backward on New England's economic history it is clear that the region has also experienced relatively long periods -- roughly 25 years -- between the maturing of one technology, with its broad income and employment benefits, and the next. The transition from one period to the next has been uneven, involving severe industry dislocation and high structural unemployment.

The process of hurrying history along through successive periods of technology development is a most complex one. Yet because the process of technological renewal is so vitally important in keeping the U.S. competitive in world markets, and persistent unemployment during periods of industrial discontinuity is so politically unacceptable, an increasing number of elected officials in the U.S are advocating new government policies and programs.

Yet the constant dilemma in developing economic policies is that politicians by the very nature of the electoral process seek short-term solutions to what is a long-term adjustment process. To be sure, achieving basic industrial structural change is a painful process for regions as for an entire nation. No capitalistic, or market-based, region or country can maintain technological excellence without some periods of discontinuity and adjustment. Certain regions of the U.S. -- such as the Great Lakes states and the Texas/Louisiana Gulf Coast -- appear to be in just such a period. I am convinced, however, that like New England these regions can resourcefully draw upon their strengths to "hurry history along" in the transition from one period to the next without major governmental intervention.

Capitalism has always gone through periods of internal contradictions. Adam Smith, Karl Marx and Joseph Schumpeter sought to address this issue of finding a suitable role for government in capitalistic economies. The dilemma is that entrepreneurial economies thrive on a _lack_ of government interference. Historically, the approach that has best resolved these differences has been the one that has involved less government.

My country is at a watershed point in its economic history. A key issue in the 1984 U.S. elections -- as evidenced in the debate over a national industrial policy -- is whether an activist role for government in the economy is the most promising approach to maintaining U.S. technological strength and vitality. How the U.S. addresses this issue -- and, more specifically, reconciles the role of government in the process -- will offer important lessons for other advanced industrial nations, such as Japan.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Senator RUDMAN. Thank you very much.

I just want to comment about one small part of your testimony. One of the most interesting things that has happened to me in the last several years has been the number of leaders of major commercial aspects of foreign governments, ministers of commerce, in particular, who have either come themselves to see me in Washington or have sent their top staff people to find out how we did it and what it does. You are absolutely right; there is a great deal of interest around the world in this program. I would not be surprised, particularly in Great Britain, to see a program emerge quite similarly, because they have had, as you well know, enormous problems in getting their not inconsiderable scientific base translated into economically viable enterprises of various kinds.

I think that we ended this just at the right time. I see that the Governor has arrived. So, I am going to ask this panel, if they would, just to step aside for a moment. It comes at a good time. I want to invite Governor Sununu forward and welcome him to the hearing.

Governor SUNUNU. Thank you, Warren.

Senator RUDMAN. How are you? I am glad you could make it this morning.

Governor SUNUNU. I am sorry to be late.

Senator RUDMAN. That is all right. I know your schedule is very busy.

I am very delighted to welcome my very good friend and Governor of our State, John Sununu, to our hearing. It is unusual when a State has a chief executive officer who, in addition to being an accomplished politician, happens to be an accomplished scientist. The Governor, of course, as we all know, was a professor at Tufts University. He has a very distinguished academic background himself and is a real friend of the high-technology industry, not only in this State but in New England.

So, we are delighted, Governor, that you could take the time to appear before us this morning. I am going to ask the stenographer that the Governor's testimony be placed in the record immediately following the opening statement of the chairman.

So, Governor, we are glad to have you.

STATEMENT OF HON. JOHN H. SUNUNU, GOVERNOR, STATE OF NEW HAMPSHIRE

Governor SUNUNU. Thank you very much, Senator.

It is a pleasure for me to be here. I must emphasize that I generally try to pick and choose those issues that I take the time to testify on, not because I want to be picky, but there are so many that are important that I want to make sure that I get a chance to participate in the deliberations.

This issue is probably the one I have leaped at the quickest to testify on because it is important not only to the State of New Hampshire but to the country. I must commend you for the foresight you showed way back in April 1981 when you filed this legislation. It is a very important piece of legislation. It was astounding to me that it had not been previously addressed effectively until you and your colleagues who sponsored the legislation brought it out for deliberations

I am here to reinforce the importance of the basic issue of making sure that our smaller firms in this country get a fair access to the Federal funds that are available for research and development, an access not only from the point of fairness but from the point of how important and crucial it is to this Nation.

I think everybody realizes that research and development, particularly in the areas that are on the cutting edge of technology, are crucial if this country is to maintain its competitive position in the markets across the world and its competitive position in making sure that we have the technology available to maintain a solid first line of defense.

All the data that I have seen, all the data that has been gathered, not only by your committee but by organizations such as the National Science Foundation, underscores how efficient and effective small businesses are in addressing research and development needs both in terms of the effectiveness per unit of dollar cost and in effectiveness in terms of output. It is crucial that we continue to make sure that that critical national resource of R&D, at the small- and medium-sized business level, continues to get nurtured.

The data in our own State is very impressive, not only in terms of what small businesses contribute directly via the R&D mechanism, but in terms of their basic contribution to the economic strength of this State. Ninety-five percent of the economic expansion and job opportunities within this State in the last 3 years has come from businesses that fall in the category of the small business definition. Ninety-five percent of the growth in jobs has come from that area. Ninety-five percent of the potential that we see for additional expansion will continue to come from small business.

We hope that they have continued access to all the resources that are available through Federal programs as well as the area that they generally do quite well in where they compete in the private sector.

Whatever assistance the States can provide to reinforce this basic approach, I assure you that that support will be there.

It is not just New Hampshire that recognizes the strength of small- and medium-sized businesses. Clearly, it has been very much an integral part of national growth. I think the data that I have cited for our own State is replicated in virtually every State across the country.

So, I commend you for what you have done. I reinforce your efforts to continue that trend, and anything we can do to assist we will be very happy to do so.

Having said that, I will be happy to answer any questions or address any other issues you would like.

Senator RUDMAN. Governor, just one issue I wonder if you might address. You may recall a couple of years ago, I was invited to appear before the National Governors Conference of which I believe you are now chairman of the Republican National Governors Conference—and the entire Governors Conference in Washington to talk about the bill. One of the things that we talked about was that some of the particularly smoke stack industry States were very anxious to start some high-technology development of their own.

I find maybe it is just a coincidence and I would like you to comment on it, our State, as your testimony indicates, has a heavy predominance of small high-technology companies. When you say they fall within the small business definition, they certainly do. In fact, most of them are well below the cap, both in terms of volume and in terms of employees.

Is it merely a coincidence or can you draw—because you know the State better than anyone else does—anything from the fact that we have unemployment in New Hampshire of, I believe, something under 3 percent, if I am not mistaken, in the high two's. Can you draw any kind of conclusion from the fact that we have this tremendous high-technology diversity and have this very, very low unemployment? Is there a connection that the rest of the country ought to look at? I guess that is my question.

Governor SUNUNU. I believe there is a connection. We now have the highest percentage of high-technology employment of any State in the country.

It has not come easily. We have traditional industries such as the shoe industry and the textile industry that have been hurt very badly by imports. Yet, there has been a good, if you will, rotation of industries as employees and investment have moved from the traditional industries that we have had in the past to the new ones. Certainly, data processing, the computer industry, information transfer, high-technology defense support, and all the ancillaries associated with that have been the heart and soul of the expansion that has taken place in this State over the last decade.

I do think there is a connection. Let me emphasize also, though, that I think the traditional smokestack industries can be served very well by the kind of program you have here. What is high technology in the public's eye is not necessarily the complete definition of high technology.

The automobile industry, certainly, has benefited and will continue to benefit from the kind of research and development that would be promoted here, whether it is in the improvement of a particular electronic component that might improve fuel efficiency, as has been seen in the past, or whether it is in the improvement in some of the research and development that might go into the materials area that would reduce the overall cost of production.

That can be done just as well and, in fact, in my opinion, more effectively in the small business arena than just larger businesses. That will make its way through the marketplace as a support component for even the smokestack industries. Even steelmaking, in my opinion, is amenable to the kind of research and development that you are talking about here.

So, yes, we have thrived on it in New Hampshire and in New England. But I really do believe that what you have here is a program that will support even the traditional smokestack industries of the Midwest.

Senator RUDMAN. I found your comment—something I only recently became aware of—rather astounding, something I tell my colleagues in Washington. They find it hard to believe, but I guess statistically, according to the Department of Commerce, New

Hampshire now has the highest high-technology employment per capita of working population in the country. And it is my understanding that the city of Nashua has the highest of any city.

Is that correct, Governor?

Governor **Sununu**. I don't know the Nashua statistic, but I do know the State statistic. I have not seen city-by-city comparisons, but I wouldn't be surprised.

It is clear that what has happened—and I must place New Hampshire in the New England context—that what has happened in New England over the past 10 years, where 10 years ago New England was perceived as being a dying region, has surprised a great number of people. I think New England and New Hampshire have built on the basic resources that we have that include excellent transportation systems, access to capital markets, education, a quality of life that continues to attract good and talented professionals and makes them feel very comfortable here, and an overall balance that is very amenable to the industries and technologies of the future.

We obviously are going to build on that. We just want to make sure that one reality that does exist up here does not become a negative, and that is that most of what we have up here is the smaller and medium-sized businesses. We have been a great area for the entrepreneur to thrive in, and certainly this legislation that you have passed is a contributor to the economic strength of the entrepreneur.

Senator **Rudman**. Well, Governor, we want to thank you again on behalf of the committee for taking the time to appear. We are glad to be in the leading high-technology State in the Nation this morning and glad to have the leading high-technology Governor in the country testify.

Governor **Sununu**. I have only one complaint, Senator, and that is that I regret that as Governor I am ineligible to apply under the program. [Laughter.]

There are those that suggest that I may be made eligible rather quickly.

Thank you very much.

Senator **Rudman**. Thank you very much.

We will ask the first panel to resume, if they will come back up here. Thank you, Governor.

Ms. Goodman, would you like to just identify yourself and your affiliation and proceed with your testimony?

STATEMENT OF HELEN GOODMAN, ASSISTANT DIRECTOR, SMALL BUSINESS DEVELOPMENT CENTER, DURHAM, NH

Ms. **Goodman**. Thank you, Senator.

My name is Helen Goodman. I am the assistant director at the Small Business Development Center at the University of New Hampshire in Durham. I am also the project director for one of our projects called Venture Capital Network, which I will tell you about later.

Basically, I am here to give you a brief overview of how we have participated in and supported the SBIR application process over the last few years. First of all, though, I would like to give you an idea of the service we offer at the university.

The office of small business programs at the university encompasses two federally funded programs, the New Hampshire Small Business Development Center or SBDC and the University Center for Technical Assistance Program or UNH/TAP. Each of these programs operates in a separate but complementary fashion providing business assistance and economic development support to New Hampshire's business community.

The SBDC was started in May 1984 and is funded by the U.S. Small Business Administration, the State of New Hampshire, the university, and the private sector. Its five business counselors provide management counseling, training, and information referral to existing and potential business owners throughout the State.

The UNH/TAP, primarily funded by the Economic Development Administration, focuses its efforts on economic development, technology transfer, and venture capital formation, with special emphasis on New Hampshire's three distressed northern counties.

Over the years, both the SBDC and UNH/TAP have been actively involved with the SBIR Program. One major effort, SBIR Data Match, was developed in 1984 to assist businesses in identifying suitable SBIR proposal topics. Usually, in order for a business to find appropriate topics, someone must read solicitations from several Federal agencies to identify topics which best fit the capabilities of their business.

SBIR Data Match was designed to facilitate and simplify this process. Our staff would read all solicitations and select key words from each abstract. These key words were matched by computer against topic key words submitted by businesses.

In addition to being a very time consuming process, it soon became apparent that key words from our applicants often did not match key words selected by our staff subjectively. The process might work, however, if a key work thesaurus were developed by the writers of the solicitation abstracts and used by businesses in describing their project needs. Due to the above problems, we have discontinued the SBIR Data Match Program.

Currently, the SBDC is acting as a link and information resource for individuals interested in competing for SBIR awards. When the SBDC receives a request for assistance, the staff sends out general information on the SBIR Program. If appropriate, the person is referred to the UNH consulting center to be linked with technical experts at the university.

Also, the New Hampshire High Tech Council provides informal feedback, support, and information to SBIR applicants. Then, if needed, SBDC and UNH/TAP staff will provide assistance on SBIR proposal writing and application procedures.

The Venture Capital Network is a not-for-profit corporation started in July 1984 and operated by UNH/TAP. It is a computerized service linking informal investors seeking opportunities with entrepreneurs seeking capital. The major areas of interest continue to be manufacturing high-technology consumer, and commercial products both from the investors' and entrepreneurs' perspective.

VCN acts as a disinterested facilitator and is an introduction service only. It does not screen or advise and withdraws from the process once the entrepreneur and investor have been introduced.

During 18 months of operation, it has been responsible for over 800 actual contacts between interested parties. Six verified deals were structured to finance specialty manufacturing companies.

In its endeavor to become a self-sufficient operation by June 1986, VCN will be launching an intensified New England focused marketing effort using financial and operational support from Deloitte, Haskins & Sells; Peat, Markwick, Mitchell; Shawmut Bank of Boston; and Price Waterhouse. These firms are interested in the phenomenal potential for high-technology and manufacturing industries in New England.

VCN has also received national attention and is assisting six not-for-profit organizations outside New England to replicate Venture Capital Network in their local areas.

To summarize, the office of small business programs has instituted a variety of approaches for facilitating and supporting the SBIR application process. Although SBIR Data Match has been discontinued, this program might provide very valuable assistance if appropriate modifications were made to the key word process.

VCN, while still somewhat experimental, has basically progressed beyond its developmental stage. It appears to be filling a specific gap in the venture capital market. It is extremely helpful to small businesses, especially emerging high-technology firms. Our office is currently supporting the management and funding of small business in a variety of ways, and I would be open to any questions about our service.

[The prepared statement of Ms. Goodman follows:]

STATEMENT FOR SMALL BUSINESS SUBCOMMITTEE

March 3, 1986

Merrimack, New Hampshire

Presented by:

Helen Goodman

Assistant Director

New Hampshire Small Business Development Center

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Small Business Development Center
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In addition to being a very time consuming process, it soon became apparent that key words from our applicants often did not match keywords subjectively selected by our staff. The process might work if a key word thesaurus were developed by the writers of the solicitation abstracts, and used by businesses in describing their project needs. Due to these problems, we have discontinued the SBIR Data Match program.

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To summarize, the Office of Small Business Programs has instituted a variety of approaches for facilitating and supporting the SBIR application process. Although, SBIR Data Match has been discontinued, this program might provide valuable assistance if appropriate modifications were made to the keyword process.

VCN, while still somewhat experimental, has basically progressed beyond its developmental stage. It appears to be filling a specific gap in the venture capital market, and is expected to reach the level required to maintain self-sufficiency by the summer of 1986.

Senator Rudman. Thank you very much, Ms. Goodman. We are probably going to have a few questions for each, but I am going to continue now with Mr. Walsh and have him testify.

STATEMENT OF BRIAN WALSH, PRESIDENT, CREARE INNOVATIONS, INC., HANOVER, NH

Mr. Walsh. Thank you for inviting me. I am Brian Walsh. I am president of Creare Innovations in the hotbed of innovation, Hanover, NH.

Senator Rudman. I am glad you pronounced Creare right. I always have problems with that.

Mr. Walsh. Many people do.

Senator Rudman. Why don't you put a phonetic under it, Mr. Walsh? Then we will all say it right.

Mr. Walsh. I don't spell very well, so——

First I want to state my support for the SBIR Program. I think it has been very important to companies I know well. I am a director of two companies, Verax and Creare Inc., both of which have participated in the SBIR Program.

When Anne called and invited me to talk, I first wondered why we were called; because we haven't participated, and I thought it would be a good excuse for me to sit down and figure out why. My knee jerk reaction to the SBIR Program initially was that we didn't want to become involved, and I thought it was time to revisit that question.

I believe the program should continue. I have seen it do good, and the intent of my comments is to give the Congress some ideas as to how they might influence the administrative process and improve the program.

My background is as a technical entrepreneur. I have been involved in the creation of three successful companies, and I am working on my fourth right now. As I look at the process of innovation, which creates jobs and creates a national capital base in technology, I think the first difficulty in the SBIR Program is timing.

As I look at the companies we have been successful in putting together, the SBIR schedule—18 months from initial concept and proposal to the completion of the phase 1 and awarding of phase 2—is a very long time. My background is in the commercial side of the world working for foreign companies and/or U.S. companies, and 18 months is just plain too long.

I don't know how the administrative processes can be shortened, but as I look at the companies we have succeeded in creating, typically in 18 months, you are in commercial sales at the $1 to $2 million a year level, not just starting your major research program. So, I think it would help the country to have the SBIR decisionmaking process streamlined.

The second issue ties into the focus of research versus innovation and development. As I read the title of the bill, it is a combination of innovation and research. I notice the title of your remarks today stressed innovation and development, not research.

My strong sense from reading the solicitations from the various departments over the past 3 or 4 years, is that the focus has been on research because development and innovation are more difficult to handle research. The focus hasn't been on development. There has been the heroic assumption that good research will naturally lead to commercialization. All of my experience says that you decide to do research and development in an area that requires commercialization and you do research and development together rather than separately.

I don't know how the legislative process can move the departments to emphasize development and innovation and understand the hand in hand relationship between the Government and the commercial sector that is required. I do know that the phase 1 proposals are looked at by scientific review committees, not commercial review committees, and there needs to be a joining there of the commercial interests with the scientific interests.

The fact that phase 1 is an 18-month period from application to the awarding of a phase 2 grant and that phase 1 grants are determined basically on a scientific basis and not on a commercial basis further pushes the program into the research rather than the development. So, I see achieving an appropriate operating emphasis on development and innovation as a challenge to the legislative draftors for the new bill.

As I look back at our corporate decision not to participate in the SBIR initially, one issue was governmental constancy of purpose. I think that is part of what this hearing is about. The history of Government programs in this country is a history of continuing waffling, and I think it is very important, given the length of time that innovation takes and given the country's commitment to using the resources of small business to create innovation, that the Government indicate a constancy of purpose by continuing this program.

If you look at the United States position vis a vis Japan, one of the things that has marked Japanese industry and government over the past 30 years has been constancy of purpose in the scientific development and commercial areas. I think it is time that the United States not look at 5-year experiments and kill them but instead sit down and go purposefully on into the next century.

The last issue, and I think it is important that it be looked at legislatively, is the issue of intellectual property rights and the public domain. I think the committee handled the patent rights correctly by granting the Government a royalty free license and granting rights to the innovator, for all other applications.

The difficult side, from my perspective, is the requirement that information developed under the SBIR Program go into the public domain in a 2-year period. Many of the innovations that the country needs under the SBIR Program are not going to be patentable, and 2 years is a very short period of time, in terms of protection, to create commercialization.

In summary, I think you are to be congratulated for your leadership in this area. I encourage strongly the Government to continue the program, and I hope my comments add to some improvements in the future.

Senator **Rudman**. Mr. Walsh, thank you. Your comments certainly will. As a matter of fact, I think we may want to talk some more to you about a couple of points that you have made at a subsequent time, because some of the points that you raise are ones that we have had concerns about.

I will ask the questions in reverse order of the way you spoke since you are up. Let me just ask you this question. Your company has not applied for any SBIR's.

Mr. WALSH. Correct.

Senator RUDMAN. And you have given your reasons, but let me just make an observation. You tell me whether it is correct or not. By the time this bill really came along, and I knew something about your company, your company had a bit of a track record. Am I correct?

Mr. WALSH. Yes.

Senator RUDMAN. So that if you had a new idea within your company that you thought could lead to research, development, and commercialization, is it fair to assume that you were in a better position than most small entrepreneurial companies in New Hampshire to go and get some venture capital or small amounts to invest or whatever you needed for the kind of feasibility we are talking about here?

Mr. WALSH. Well, that might have been the case, but all of the businesses that we have spun off directly ourselves we have spun off based on our own financial resources. Basically, what that means is that we have worked like hell developing products for others to earn enough money to be able to launch the businesses. So, we haven't used venture capital. We are in the process of using that now.

Senator RUDMAN. But you were in a position to find a way to finance at least feasibility studies?

Mr. WALSH. Yes.

Senator RUDMAN. As hard as that may have been, and I am sure there is a lot of sacrifice involved, nevertheless, you did have at least that basic resource.

Mr. WALSH. Yes. We were in a position to devote skills, energy, and a little bit of money to the feasibility level.

Senator RUDMAN. You see, a lot of people have two of the three. They have the skill and the energy. They have three; they have the idea, also, but they just have no way to raise that initial seed money just to prove that it will be the best widget anybody ever saw. That is one of the real problems, of course, that this tries to address.

But I think your comments are very well taken on tying research and development together more closely in terms of eventual commercialization. That is something we really would like to talk about and at length that we don't have really time to do. So, I am going to make sure we talk to you about that at some time in the future.

Those are interesting views, and you are certainly in a position to talk about them.

Ms. Goodman, I had, as I listened to your testimony, just one question, I guess. I was curious how much tracking you have done on these 800 contacts. What kind of track record is there? Have you tracked it in terms of what the investment ratio is?

I understand what you are doing. I guess what I want to know is, is it working?

Ms. GOODMAN. Well, we are in the process of finding out more about that. The fact that we are a disinterested facilitator, we pull out of the deals once the contacts are made. Now that we are finished with the developmental stage we are trying to do some followup.

We have been able to verify 6 actual deals where money has been exchanged in the neighborhood of $20,000 to $400,000. We also obtained feedback from about 12 more entrepreneurs who said they were in active negotiation stages.

So, we have had very little feedback, but we are going to attempt, now that we have a lot of the other processes worked out, to verify more and more of the funds exchanged.

Senator **Rudman**. The reason I ask the question is that there were a couple of very interesting arguments made by opponents of this bill. One of them was that there is always venture capital. This country is full of venture capital. Well, that is true, but it generally is venture capital, in most cases, given to people with some kind of a proven track record, with some history, generally, or an extraordinary idea—of which there are many.

However, by and large, small entrepreneurs have a hard time getting venture capital for essentially feasibility.

Ms. **Goodman**. VCN was developed as a different type of funding mechanism It is designed for informal investors, many of whom are looking not only in equity investments, but are also interested in having some type of role with a company, either because they have been entrepreneurs themselves or have a particular area of expertise.

Usually, the deals that are funded are companies that are too small or too high risk to interest the professional venture capital firms. Most investors are looking to make investments between $20,000 and $200,000. Some are interested in coventuring. One man who has allowed his name to be used in the press, Francis Metchner, from Stamford, CT raised 20 percent of his equity financing through 9 VCN investors who were willing to coventure.

VCN is designed to inform investors about companies that might not attract professional venture capital firms or might not be able to get bank financing. It is very much designed for the early startup or seed capital stage, although it can also attract funding for established firms.

Senator **Rudman**. To the extent that you develop statistics, we would like them, if you can share them with us.

Ms. **Goodman**. I would be very delighted to share the information with you.

Senator **Rudman**. I think my question to you, Bill Fletcher, is really a follow-on to that, and then you might want to comment generally. I guess what I want to know is, do you have any ideas on matching the companies with the venture capital as something you have done something of? At what point? Because I am not sure we can do anything in the legislation, and I am not sure we want to, but certainly having more of a knowledge base about that aspect certainly helps us in what we are doing.

Mr. **Fletcher**. I am familiar with what VCN [Venture Capital Network] is trying to do. I just heard about the proposal in the testimony here about a more appropriate key word kind of process to help with the SBIR awards. But I think the aims of the VCN are important.

It is a very difficult process getting together the small amounts of seed money, amounts represented by the phase 1 SBIR awards of $50,000.

Mr. Walsh of Creare mentioned that he is not participating in the SBIR Program, and I mentioned at the beginning of my testimony that Termiflex is not. We are in a stage in our development where we are not trying to develop an idea now. We are trying to grow an idea which we have finally managed to prove out will work.

We were, though, back in 1973 when we started the company, in a position where an amount of money represented by SBIR phase 1 awards was in fact exactly the amount of money that got the company started. It was a $50,000 availability of seed money—a very difficult kind of money to get.

The company I founded before that also started with $50,000 worth of seed money to put the idea together. The results of spending that first $50,000 were approximately a business plan that thick, and then we went on for subsequent financing.

So, whereas I am not now participating in the SBIR Program with the company at its present stage of development, I have in the beginning of this company and the one previous to that been fortunate enough to be able to find a source of that amount of seed money to get the companies started.

Without that initial seed, neither one, neither Termiflex nor the company before that, would presently be in existence, and the total amount of employment in the companies that I have been involved in founding now is in the several thousands.

Senator RUDMAN. Obviously, you were able to do it, but the testimony overwhelmingly that we have had is that most people can't.

Mr. FLETCHER. I am actually supporting that. I was just very lucky and it just happened to click.

Senator RUDMAN. No; I am saying that you make a very good point that you were able to do that. The question that nobody really knows is how many jobs would have been created, how much more could we have added to the GNP, how much healthier could the economy have been, what kind of breakthroughs could we have had in health care, in so many areas, had we had a program like this 10 years ago that had been followed and followed faithfully? How many more Termiflexes and Creares are there out there that we don't know about?

We believe there are many. We believe that the data base that this committee has put together on the basis of its hearings and the National Science Foundation proves overwhelmingly that this country is full of incredible innovation, much of which cannot get the original money to prove that the idea works.

So, we are delighted with your testimony from all three witnesses on this first panel. We appreciate your taking the time. Thank you.

We are going to call the second panel: Dr. Chuck Crawford of Kimball Physics in Wilton; Dr. James Block, president of Creare—I guess I have that right now—in Hanover; and Mr. Fred Schmid, president of Crystal Systems in Salem, MA.

Thank you very much for taking your time to come and tell us your experiences with the program. Is there any order in which you people would like to proceed? If not, I will start probably with Mr. Schmid. To the extent that you can observe our time limitations the staff told you about—I am not going to cut you off, I hope—but I would like you to get as much testimony compressed as possible, and your entire statement, if you have a statement that is longer than that or any other data you want that will be printed in the permanent record of this hearing, you may submit that.

So, Mr. Schmid, we are glad to have you up here this morning.

STATEMENT OF FREDERICK SCHMID, PRESIDENT, CRYSTAL SYSTEMS, INC., SALEM, MA

Mr. SCHMID. It is my pleasure to be here to testify.

I am Fred Schmid, president of Crystal Systems that I formed in 1971. Crystal Systems is a company that is based upon a new technology, a new crystal growth technology called the heat exchange method. This is a technology that competes with the Chrikowski method which is a technique where 95 percent ot crystals in the world are made for silicon, for lasers, that sort of thing. So, it is a very important development considering that the greatest technological developments had been made in the solid state area for electronics, electro-optics, where we are looking at integrated circuits, lasers, fiberoptics, that sort of thing.

So, it is an area of a lot of technological development.

The goal of the company is to extend this technology to other materials. So, the SBIR situation is a very good one for us.

As I say, I formed the company in 1971 and spent 3 years commercializing the technology for the growth of sapphire. After 3 years, we had a commercial product. Then, under a DOE program, we adopted this for the growth of silicon for photovoltaic applications and, in 1979, picked up one of the first SBIR programs in an NSF program to show that in fact this technology was capable of growing crystals for laser application. We were very successful in that.

Today, we have six phase 2 SBIR's and three other DOE and Department of Defense contracts which total about $1 million. Our commercial sales are about—well, the SBIR and the other contracts are about $1 million and the commercial sales are about $2 million. So, it is about a two-thirds to one-third relationship.

Our business is a materials science, and it is a business that involves a lot of capital investment, and technological developments do not come easy. It usually involves some sort of advancement of science. It is basically a long-range, high-risk situation, and you develop technology to grow a new crystal. Then, in fact, someone else has to develop a system to use that new crystal and, then, that system, of course, has to go to the marketplace.

So, we are looking at real long-range kinds of stuff, 15 years. The fact that you are looking at such a long-range situation, the fact that it is a very capital intensive situation makes it very unattractive to venture capital or to, for that matter, any other investor.

We have been able to raise money for the commercialization of the technology for the growth of silicon through subordinated debt through MTDC [Mass Technology Development Corp.] and Capital Resource Corp. But even after having raised money through subordinated debt through those people, venture capital still would not be interested. It is a slow, steady type of growth; it is not exponential.

So, the business has to be profitable because you have to go for a lot of bank financing, and it is not the exponential situation that venture capital is looking for.

We have been very successful in the SBIR Program. We have made 18 proposals and had 16 awards.

Senator Rudman. Can you tell us which agencies they were from, not one by one but just——

Mr. Schmid. We have had from NSF, Department of Energy, and DOD. Those are the ones, about equally spread.

Now, one of the reasons for our success rate, we believe, is that we believe that the SBIR's are not an end in themselves. We position ourselves to commercialize any technology on which we write a proposal. So, we are pretty much ready to go.

This involves a very careful selection process, though. We review the market with respect to new technology crystals to see what the potential is. Typically, it is military, but you can often find some civilian offshoots. Then, again, we look at the market situation with respect to how would it in fact benefit us as a complementary. We look at our technology to see if it has significant advantages over current technology to assess the probability of success.

Then, one that is very critical is to determine the level of effort is consistent with an SBIR Program. A lot of work is far beyond a 2½-year SBIR $500,000 situation, and it would not be beneficial for us or for the Government for us to put a proposal in for something like that.

So, that is basically our selection process which also involves whether we have the personnel and facilities to conduct our work.

Our first program was the NSF Program in which we showed that this technology is capable of growing crystals for laser application, and that opened up a whole new area. We were able to follow that up and produce laser crystals necessary for the DOD in which we did get followup funding, as a matter of fact, from Sanders on one of their Air Force programs.

We currently have an NSF Program that is going into completion, and I do have a crystal back here to show just what we produce, and there we are producing a laser crystal, titanium sapphire, which is very important for the SDI Program. When we started this, again, the SDI Program wasn't even conceived, but this is an extremely important development for that, and this is the kind of thing that happens. Often, you can't foresee it.

Senator Rudman. You answered one of my questions. I was going to ask you, obviously, listening to your testimony and being on the Defense Appropriations Subcommittee, whether or not you were involved in any way with SDI, and I assume you are.

Mr. Schmid. Yes, on this, and actually the sapphire crystals and the silicon crystals. We have gone into optical application there also, and they are very, very critical to the SDI Program.

Senator Rudman. The optical laser field, is that one of the areas that you would be making crystals for?

Mr. Schmid. That would be one. Another one is for the transmission of infrared. You have to have windows in front of detectors to protect the sensing devices, and you need a window which can stand up to extremely high temperature, abrasion resistance, and a number of other critical parameters.

So, a lot of the things that we have done are very, very critical to the SDI, and we are very heavily involved in that program.

That is the kind of marketplace that we have. Typically, it is very high technology working with Hughes, TRW, and McDonnell Douglas, and other very large companies.

For our type of business, we believe it is unrealistic to expect some outside investor to make investments have a 2½-year program. We, in fact, have to pick it up and take it further to show that it has potential technologically and market potential. That probably is not true for all of the SBIR Programs. Ours again involves a lot of scientific development and advancement. It is not product development by any matter of means.

The SBIR Program has been extremely important in broadening our market perspective and giving us a great deal more insight into our technology and so we can expand it. It is a very broad type of thing that you can't put your finger on here or there. It is just a matter of putting all these technological developments together and being able to really understand the technology better and being able to commercialize it and take advantage of it at a much faster rate.

I guess one of the things that we see with the SBIR Program is that there really is not a very close working relationship between the agency and the small business. Once the phase 2 program is let, there really is not very much management. I believe that small companies could become complacent. The agencies really should have a better management and control of it.

It seems that at the 1-year mark, there should be some interaction where someone would have to defend what they are doing to see if in fact they are using that money effectively. That doesn't exist.

Senator RUDMAN. Are you saying that generally of the agencies you deal with pretty much equally?

Mr. SCHMID. That is correct. And I believe that is true across the board. There really should be stronger management of these programs. They may have gone well, but everything that I have seen, if in fact you don't manage something and see it closely, it can go off in some other direction and you don't get the full benefit from it.

Senator RUDMAN. Let me see if I understand your testimony correctly. Are you talking about at the end of phase 1?

Mr. SCHMID. I believe that at the end of phase 1 it would be very good to really have a good debriefing and then, before a phase 2 program was let, to make sure that you have the technology that is worth taking forward. Then, when the phase 2 program is let, there should really be after 1 year a technical review also which really is a review that would be critical in going forward with that so the person knows that in fact they have to perform.

Senator RUDMAN. But phase 2, of course, is supposed to be based on a critical review of whether phase 1 worked. Is that not true?

Mr. SCHMID. Yes, but there really is not a lot of management there, so people can go off in different directions. Sometimes you

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have to, but it is fine if you are doing it to achieve the end result. But there really is not much direction there, and a small company could become very complacent in how they are utilizing those funds.

Senator **Rudman**. Well, that is a very interesting comment, Mr. Schmid. I am going to ask if we can go on to Dr. Block and come back with questions unless you have something else you want to put in there.

Mr. **Schmid**. I guess the other thing that I think is in some of the larger programs that we have been involved in in particular technological areas; for example, in the photovoltaics, we have had a lot of the people involved in those contracts come together and have meetings. It seems that the same thing could be true here, that there would be a meeting in a particular technological area where all the agencies that are involved in that technology and all the contractors would be required to discuss what they are doing so that there wouldn't be—to see if there is a lot of overlap and also to exchange information.

I think that there is a problem with a lot of information exchange, and this could really help to improve that.

Senator **Rudman**. Let me just comment that one of the things that we tried very hard to do—maybe we have done it too well—was to de-bureaucratize this program. One of the things that we were sure would kill this program was to have it too heavily involved with the bureaucracy, and we tried to make things simple.

Now, maybe the agencies have taken us at our word, according to your testimony, too vigorously. I have looked at a number of phase 1 and phase 2 awards and thought that there was pretty good evaluation at the end of phase 1 before phase 2 was in fact awarded. As a matter of fact, I have had just the opposite complaint, that sometimes they expected too much in phase 1 and didn't get to phase 2.

[The prepared statement of Mr. Schmid follows:]

CRYSTAL SYSTEMS INC.

Statement presented to Committee on Small Business,
Subcommittee on Innovation and Technology, March 3, 1986
at the Oversight Hearing, Merrimack, New Hampshire

Re: Small Business Innovation and Research (SBIR) Program
P.L. 97-219

By:

Frederick Schmid
President
Crystal Systems, Inc.
Salem, MA 01970

CRYSTAL SYSTEMS INC.
[illegible]

Crystal Systems is a leading company for the production and development of high-technology crystalline materials for the electro-optic, optical and photovoltaics industries. Crystal Systems, Inc., (CSI), uses its unique Heat Exchanger Method (HEM™) of crystal growth to produce the world's largest sapphire and the only sapphire free of light scatter. Both its size and its quality have made CSI sapphire in high demand in worldwide optical markets.

Crystal Systems is an independent small business which was formed in 1971 by Frederick Schmid for production of sapphire by HEM. Development began in 1972 and CSI entered the market in 1973--remaining profitable every year to date.

The Company's key strength has been its ability to focus R&D on high-technology crystals that have important markets and to apply its technology developments to profitable production. CSI has a significant R&D effort to adapt the HEM technology for growth of crystals with significant commercial markets, and to develop a new wafering technique called the Fixed Abrasive Slicing Technique (FAST) to slice expensive industrial crystals such as GaAs.

A major portion of this R&D effort has been sponsored by contracts with government agencies, including NSF, DOE and DOD, frequently through SBIR grants. Close working relationships have been developed with outstanding research laboratories such as MIT's Lincoln Laboratory, JPL, Lawrence Livermore Laboratory and Brookhaven National Laboratory.

CSI has received nine Phase I and seven Phase II awards under the Small Business Innovative Research (SBIR) program. Presently CSI is working actively on six Phase II SBIR R&D programs, two Department of Defense programs and one Department of Energy program to produce high-technology crystals with HEM, and to commercialize FAST for slicing GaAs. Crystal Systems is also internally funding R&D to adapt HEM for growth of GaAs.

The major markets for sapphire and silicon are domestic, but the export markets are rapidly increasing as foreign countries expand their technological base. Revenues from commercial sales of sapphire and silicon represent 66% of income and contract research represents 33%.

The underlying HEM technology was initially developed by Frederick Schmid while he was a government researcher at the Army Materials and Mechanics Research Center. This work established the concept for directional solidification of large single crystals by the Heat Exchanger Method. Since then further development and commercialization of HEM has been carried out at CSI. Eleven patents were developed and these are held by CSI for growth and slicing of crystals.

The Heat Exchanger Method (HEM) has opened a new era in crystal growth where large crystals of high crystal perfection can be economically produced. Sapphire crystals 10 inches in diameter, 5 inches high, are grown in a number of crystal orientations, making it an exceptional material for a broad range of optical, mechanical and electronic applications. The availability of the large diameter sapphire, free of light scatter, is necessary for the success of the Strategic Defense Initiatives.

Under a six-year DOE program started in 1975 the Company adapted HEM for production of silicon for photovoltaic application. On the basis of this technology development, CSI secured $750,000 subordinated debt in 1981 from Massachusetts Technology Development Corporation (MTDC) and Massachusetts Capital Resource Company (MCRC) for commercialization of HEM for photovoltaic applications. CSI has successfully commercialized HEM and is currently selling photovoltaic silicon domestically and throughout the world, including Japan.

Large silicon ingots are manufactured and sold to the photovoltaics industry to meet the need for low-cost, high-efficiency material to economically produce high-power photovoltaic modules.

Large optical multicrystalline silicon--16 inches in diameter--is the most recent CSI commercial entrant into the materials market, permitting the development of applications for optical silicon where size has been a limiting factor. HEM silicon is currently used on Air Force One for countermeasure. The HEM technology for producing large-diameter optical silicon is an important asset for making SDI viable.

Research and Development

In addition to internally funded R&D efforts to improve the HEM process for products such as large high-quality sapphire and silicon, CSI performs contract research on development of HEM to produce materials that have significant markets. The Company's present SBIR contracts center on crystals such as $Co:MgF_2$, $Ti:Al_2O_3$; BCO, GSAG, CdTe and ALON. These materials are for advanced solid state laser, detector and scintillator applications. Early uses typically involve military applications, but commercial offshoots are likely.

For the past two years CSI has been pursuing development of HEM for growth of gallium arsenide (GaAs). Initial research was funded by a partnership with Cabot Corporation. The present effort is carried on through Ghemini Technologies, a division of Crystal Systems located at the parent company Salem facility. This research has demonstrated that it may be possible to produce large undoped "dislocation-free" GaAs crystals with semi-insulating properties by HEM.

Organization and Management

Ownership of CSI rests in a controlling interest held by Frederick Schmid, founder and president, and substantial interests held by two independent businessmen who provided early financing. The Company occupies approximately 10,000 square feet of office, R&D and manufacturing space in Shetland Industrial Park overlooking Salem harbor. CSI employs 30 people, approximately two-thirds of whom are directly engaged in the technical effort. The present location in a renovated textile mill is ideal for the HEM process because of availability of high-bay manufacturing space, accessibility to a dependable power source and sufficient labor supply. These factors combine with an aggressive sales and marketing effort promoting CSI materials throughout the world to give the Company an attractive and promising profile in the materials industry.

Small Business Innovation and Research (SBIR) Program

Government contracts have been extremely important to extend the HEM technology to other materials and to gain a much deeper understanding of the technology. This has allowed Crystal Systems to expand and increase its market base.

Crystal Systems has been very successful in getting SBIR awards. The Company has submitted 18 SBIR proposals and received 16 grants--a success rate of 89 per cent. The reason for such a high rate of success is our own careful selection process which involves the following analysis:

1. Thorough review of the market needs with respect to new high technology crystals
2. Determine if the market would be complementary to our existing market and would be beneficial for us
3. Critically analyze our own technology to determine if it has significant advantage over current technology
4. Access the probability of success in terms of producing a high-technology crystal and learning more about our technology that would be helpful for our existing production
5. Determine if the level of effort involved is consistent with the SBIR program scope
6. Determine if we have the necessary facilities and personnel available to conduct the program

For agencies other than National Science Foundation (NSF), the market needs are mostly military, but the technology developments can open civilian markets. We look at this aspect very carefully since we are interested in having a good balance between military and civilian markets. The question of technological difficulty is critical in terms of the money and time that is available for the program. Most of the technological problems that must be solved in our area--the material industry--are difficult and involve some type of scientific advancement, and therefore require large investments of time and money. SBIR programs are typically only 2½ years long and up to $500,000, and therefore the problems that can be addressed are limited.

Crystal Systems has had nine Phase I awards and has decided to follow up on seven of the grants. Two Phase I programs were not continued since the probability of success during Phase II was low.

Our first SBIR program in 1979 was an NSF Phase I and Phase II grant to produce tunable laser crystals. We received a follow-up contract from Sanders Associates for an Air Force contract for laser communication. This military market is currently on hold and no commercial markets have developed.

Crystal Systems is currently working on six Phase II programs. A DOE SBIR for a scintillator crystal will be complete this month, but more R&D is necessary before outside financing will be possible, since the technological risk is still too high. An NSF SBIR program for growth of laser crystals ends this fall, and we expect to go forward into the prototype production stage with this program if the market is large enough, and if additional capital is required, we will seek outside investment.

Our first government R&D contract was in 1975 with DOE for adapting the HEM for growth of silicon for photovoltaic application, and for developing FAST for effectively slicing silicon bars into wafers. The program lasted for six years and cost about $2.5 million. On the basis of the technological progress, we raised $750,000 of subordinated debt for commercialization of HEM growth of photovoltaic silicon. Venture capitalists would not make any investments in this technology even after we received the subordinated debt.

The FAST technique was not ready for commercialization and therefore we carried on limited development and demonstration on our own. Over a period of four years we were able to show that this technique has significant advantage over current technology for slicing GaAs--an important new material. We received an SBIR award from DOE to develop this technology for slicing GaAs for solar cells.

Progress on the DOD SBIR for FAST slicing GaAs has been good. We expect a large market potential for this technology and will need a large capital investment to commercialize this slicing technique. In light of the market potential and large technology developments that have occurred under a six-year DOE program and the 2½ year DOD SBIR we expect to be able to raise capital through third-party financing for commercialization.

This is used only as an example to show that in our type of business a great deal of time, money and patience is required to commercialize new developments. Outside investors such as venture capitalists do not have much time or patience, and therefore a company must be positioned to continue promising developments on its own before it can attract outside investment. Contracts are granted because the technological and/or market risk is high.

We believe that it is unrealistic to expect outside investment after the 2½ year, Phase I and Phase II have been successfully completed. The programs involve high technological or market risk that typically cannot be sufficiently reduced in 2½ years to warrant outside investment.

We have had considerable experience in contract R&D over the past 11 years. We believe the SBIR programs are very important for small business and for the nation. The SBIR programs give small companies an opportunity to demonstrate and develop their technology to solve national problems. Often small firms can achieve solutions to national problems faster and at much lower cost than large corporations.

We believe the SBIR programs would be improved if there were a closer working relationship between the contracting agency and the small business. In addition, it would be helpful if companies working in common areas, such as materials science, would have regularly scheduled meetings among all the agencies and the small business with grants in that area.

We believe that Phase III SBIR awards should be made when sufficient progress has been made during Phase II, and when cost sharing can be arranged through third-party financing.

Frederick Schmid
President
Crystal Systems, Inc.
Salem, MA 01970

March 3, 1986

VITA

FREDERICK SCHMID
President
Crystal Systems, Inc.
27 Congress Street
Salem, MA 01970

Frederick Schmid, President of Crystal Systems, received his Bachelor of Science degree in Mechanical Engineering from Lafayette College in 1959, a Master of Science degree in Materials from Northeastern University in 1967, and completed course work for the Ph.D. in Materials Science at MIT prior to establishing Crystal Systems.

Schmid's background includes R&D in physical metallurgy and solidification processing of metals and ceramics. Schmid developed the Heat Exchanger Method (HEM™) for directional solidification of ceramics at the Army Materials and Mechanics Research Center in 1967. In 1969 he and a co-worker demonstrated that HEM can directionally solidify sapphire single crystals from the melt.

Schmid formed Crystal Systems in 1971 and has successfully transferred HEM from a laboratory process into a commercial operation. At Crystal Systems he has developed HEM for growth of silicon in 1981 and has successfully commercialized this development. In 1973 he invented a new slicing technique called the Fixed Abrasive Slicing Technique (FAST) for slicing high technology crystals more effectively. He has more than 10 patents on solidification and slicing and has over 30 scientific publications. In 1983 Schmid received the F. H. Norton Distinguished Ceramist Award from the New England Section, American Ceramic Society. He received the IR-100 award for sapphire in 1973 and for silicon in 1979.

Senator **Rudman**. But we will go on to Dr. Block, and we will probably come back. Thank you very much for your very interesting testimony.

Dr. Block, welcome. Please proceed.

STATEMENT OF DR. JAMES A. BLOCK, PRESIDENT, CREARE, INC., HANOVER, NH

Dr. **Block**. Thank you, Senator Rudman.

Small high-technology businesses are precious resources to our Nation. Numerous studies have shown they are leaders in innovation and employment growth. Our Government agencies need to fully use these resources. It is in the mutual interest of small business and Government to work together because of the skills and because of the creativity and responsiveness small business can bring.

Traditionally, this has been a very hard thing to accomplish, getting small businesses working effectively with Government agencies, but the SBIR Program has been a truly exceptional vehicle for making this happen.

Creare was founded 25 years ago. It is a mechanical engineering service company, and computer software products company dedicated to technological advances in a variety of mechanical engineering areas. We have an international client base among traditional world leaders. Most of our business comes from industry rather than Government, but we also have a number of significant Government projects.

We are forefather of a number of high-technology companies located in Hanover, NH. We have received SBIR awards from a number of the agencies.

A brief listing of some of the projects we are doing shows the diversity of our people and our business. We are working in cryogenic turbine machinery, and I will say a little bit more about that later. We are developing a software system to assist in the teaching of science in our secondary schools. Another software project involves the use of expert systems to assist in the evaluation and identification of scientifically gifted students. We are working on several projects that involve advanced heat transfer, one for the Air Force and one for NASA. We are doing a project for NIH that involves better understanding of the blood flow in the human body. Again, that is computer software related. We are developing a tactile aid, as we call it, a means to allow severely hearing impaired people to be able to understand speech. We are doing a project for the Air Force that involves keeping ice out of high performance aircraft, out of the interior of the aircraft, keeping ice off the electronics.

So, these give an example of some of the breadth of our work. The underlying threads of what we do are basically mechanical engineering and computer software.

I would like to give an example of how the SBIR Program has benefitted us and talk about one of the phase 2 projects we have recently completed. This was a project performed for the Department of Energy to develop a very unique pump which would pump cryogenic fluid, basically pump or compress very cold helium.

The basic device has a number of applications, including magnetic refrigerators for space, transfer of hydrogen in space for NASA, and the specific DOE application which involved cooling of superconducting magnets for high energy physics experiments.

We developed a unique pump which is extremely reliable, has a long life, low maintenance and, most importantly, is noncontaminating of the helium. We did this by hermetically sealing the pump unit and using the cryogen itself for lubricating the bearings.

Fermi Lab is a laboratory in Illinois which has the United States largest superconducting magnet facility to accelerate particles to very high velocities for basic research. They have an inplace investment in these magnets of over $1 billion. The hope is and our expectation is that by putting a number of these pumps we have developed around their loop of magnets, they can achieve a 25 percent increase in the energy levels available at this facility which will provide a very cost effective way of maintaining the U.S. leadership in high energy physics.

Senator Rudman. Dr. Block, would you actually manufacture this product after you develop it?

Dr. Block. Yes. And that actually leads me into a comment I wanted to make about phase 3 commercialization.

In a number of the phase 2 projects we have, we have decided to commercialize the results ourselves. In some of them we have decided to link up with a larger firm. For this particular cryogenic pump, it is something we very much can make ourselves. The number of units needed is not very large. It does not have a huge marketplace, but these pumps are very specialized pieces of machinery so that the selling price of each of them is fairly high.

So, it is very consistent with our style of not wanting to get into volume manufacture but willing to do high technology specialized manufacturing.

It was important to us in getting phase 2 that DOE, as does many of the agencies, would accept a self-commitment for funding phase 3 as a valid commitment. Not all agencies accept a self-commitment as a valid commitment; they demand a third party. I don't agree with this, because, in effect, they are asking a small business which can commercialize something to give away some of the downstream rights. So, I would like to see all agencies accept self-commitments from the small business. They should evaluate them very carefully to make sure that they are real, that the small business has the capability of actually commercializing something, but if the small business can commercialize it themselves, they shouldn't be penalized because an agency wishes to get a third party involved.

Senator Rudman. I suppose that has a great deal to do with how reasonably or how realistically those who look at down sheets or business plans are to assume that a certain amount of capital, *x* amount of capital, is going to be in place for a particular investment at a particular time. I assume that is a difficult thing to do, but I am sure it can be done.

Dr. Block. Well, many agencies do allow self-commitment, and I would like to see all agencies allow them as valid third party commitments.

One of our projects, to look at the other extreme, involves developing a component for an MRI system, a magnetic resonance imaging system, to do whole body pictures of the human body. There, we are critically dependent on interacting with the whole several million dollar MRI system. In this effort, we have chosen to link with one of the leaders in the MRI field to do phase 3—actually, working closely during phase 2 to make sure that our design is practical and reasonable and then they would be the phase 3 takeoff partner.

We are also, interestingly, in phase 3 in a sense in a couple of our projects that haven't yet finished phase 1. By that I mean the SBIR Program allowed us to sell our basic technology in a particular area we had not worked in before. The particular area in this case was electromagnetic launch. We received a phase 1 project. We are now in phase 2. But prior to entering phase 2, we received a number of subcontracts from prime Air Force contractors in this particular field based on the work we had done in phase 1.

I believe there is widespread interest in small businesses in the SBIR Program, because it allows small business to do what they know best, research and development. The rules are set up to minimize the problems that small businesses face in marketing to the Government. Small businesses typically are not good at selling, certainly not good at dealing with bureaucracies, and they are certainly not capable of withstanding long delays.

The Small Business Program has addressed many of these aspects. The SBIR Program structure makes writing the phase 1 proposal simple and easy, and I strongly urge the retention of the 25-page limit.

Creare has won awards from over half the agencies, and our experiences with all of these agencies have been excellent. One I would like to compliment in particular is the Department of Energy. I would like to compliment the Department of Energy for setting up a workable system to evaluate phase 1 results, and fund phase 2 projects right at the end of phase 1 so that the project can continue from phase 1 to phase 2 without a debilitating gap.

Senator Rudman. I think Mr. Schmid was talking about that, really, to some extent. You are saying they have done a pretty good job with things you are familiar with.

Dr. Block. DOE has a system that allows early submission of phase 2 proposals. They turn the evaluation around very quickly and if they think you have done a good job, they will award a phase 2 project so that you can start up without any gap between phase 1 and phase 2. In the case of our two DOE projects, the technical monitors from DOE visited us toward the end of phase 1, saw what we were doing, and evaluated what we were doing. I wish other agencies would follow the lead in shortening the time scale between phase 1 and phase 2.

Senator Rudman. A lot of that has to do with people. You are familiar with the gentleman who directs that over at Energy? When you get the right person, well motivated, understands what the program is about, believes in the policy, you can get it done. If you get somebody with a poor attitude, and you can get just the opposite result with the same statute and the same regulation. So, it is a question of getting the right people in the right job. It is no different in government than it is in private industry.

Dr. Block. Right. I certainly agree with that. And in the case of DOE that gentleman is Dr. Ryszard Gajewski.

Well, in summary, I have high praise for the SBIR Program and its creators. It has certainly had many benefits to the Nation.

Just as a comment, I am reminded of a study that Battelle Memorial Institute did in 1973 on innovation. They looked at a number of critical innovations and determined that the average time between the first conceptualization and commercialization, the first commercial realization of the invention, has been 19 years.

Senator RUDMAN. Better than the amount of time it takes us to develop a weapons system at the Pentagon, Dr. Block.

Dr. BLOCK. Yes, but it is still 19 years. Although the SBIR Program has already benefited the Nation and the benefits are fairly clear in a number of cases, it is important I think to realize that the most significant benefits from this program are probably yet to come because of this 19 years. This is one of the powerful reasons I feel that the program ought to be continued.

[Prepared statement of Dr. Block follows:]

SBIR PROGRAM

Testimony by James A. Block
Creare Inc., Hanover, NH

To the United States Senate, Committee on Small Business Oversight Hearing on the Small Business Innovation and Research Program, P.L.97-219.

March 3, 1986

Small, high technology businesses are precious resources to our nation. Numerous studies have shown they are leaders in innovation and employment growth. Our government agencies need to fully exploit this resource. It is in the mutual interest of the government and small businesses to contract with each other for the conduct of research and development projects. The government can expect of small businesses a much higher degree of creativity and responsiveness then is characteristic of industry at large. The SBIR program is a truly excellent vehicle for the government to tap the resources of the small businesses and for small businesses to efficiently address the needs of government agencies. The SBIR program has and will continue to support the development of existing innovative ideas and inspire the creation of new innovative concepts and inventions. Many of the innovations made possible by this program would merely remain as ideas - unexplored and undeveloped - if there were no SBIR program.

Creare has received awards from many of the agencies participating in the SBIR program. To date, all of our Phase II proposals which have been decided have been accepted for award. I would like to tell you a bit about our experiences with the SBIR program. I will particularly focus on what it has meant to Creare as a typical small business. I will do this by briefly describing some of our SBIR projects.

Creare Inc. is an advanced engineering and computer products company serving an international customer base. Since 1961, Creare's engineering services have spanned applied research, engineering design, new product and process development, and computer software development and applications. Creare's current products include cryogenic refrigeration, fluid flow analysis software, turnkey data acquisition systems, and software for graphics and analysis. Creare is the forefather of a family of high technology manufacturing and engineering companies.

Creare serves diverse industries, and this diversity is reflected in our SBIR awards. We have received Phase I awards from DOE, DOEd, DOD-Navy, DOD-Air Force, DOD-SDIO, NASA, NRC, HHS, and NSF. The topics of these SBIR projects have included cryogenic refrigeration systems and components, software for teaching science and identifying scientifically gifted students, advanced heat transfer techniques for terrestrial and space applications, software for understanding blood flow through the human body, a tactile means to communicate speech to severely hearing impaired individuals, a device to prevent ice build-up inside high performance aircraft, and a screening system to help reduce the number of alcohol impaired drivers.

Creare has completed two Phase II projects, has two in progress and expects soon to begin a fifth. Information on these five Phase II SBIR projects is provided below.

Title: TURBOEXPANDER FOR CRYOGENIC HELIUM REFRIGERATORS AND LIQUEFIERS
Client: Department of Energy
Phase II Funding: $490,635

A pair of turboexpanders with self-acting journal bearings and pressurized gas thrust bearings have been designed to increase the performance and reliability of refrigerators used to cool superconducting magnets for high energy physics research. Prototype hardware has been constructed and performance tested and will ultimately be installed in a commercial helium liquefier for on-site evaluation.

Title: HIGH SPEED CRYOGENIC HELIUM PUMP
Client: Department of Energy
Phase II Funding: $486,261

Creare has developed, demonstrated, and plans to commercialize a reliable, long life, centrifugal pump for circulating liquid or supercritical helium. Currently, prototype hardware is being tested at a National Lab to demonstrate performance characteristics including efficiency and ruggedness.

Title: AN EDUCATIONAL DATA ACQUISITION SYSTEM FOR USE IN SECONDARY SCIENCE COURSES
Client: Department of Education
Phase II Funding: $201,800

The objective of Phase I was to describe and assess a complete Educational Data Acquisition System (EDAS) that includes instrumentation, hardware, and computer software for a series of experiments to be run on microcomputers in secondary school science laboratories. The EDAS has the potential to enhance the productivity and relevance of science laboratorie while encouraging students of all ability levels to achieve their potential. Based on Phase I, Creare has produced a working prototype in Phase II and is using it in a representative school for an extended trial.

Title: LIQUID HYDROGEN COOLED CONDUCTORS FOR PULSED HIGH POWER APPLICATIONS
Client: Department of Defense (Air Force)
Phase II Funding: $494,745

A novel concept for electromagnetic propulsion involving multiple conductors cooled by circulating liquid hydrogen is being developed. The potential of this concept is to permit repeated power bursts without burnout of the device.

Title: A RELIABLE, LONG-LIFETIME CLOSED-CYCLE CRYOCOOLER FOR SPACE
Client: NASA
Phase II Funding (Anticipated): $499,953

A simple, reliable long-life cryocooler for space applications is being developed. The cycle is designed to provide approximately 5 watts of refrigeration at about 70°K with a target power-to-load ratio of 30 watts per watt. The cryocooler will be a reverse-Brayton cycle using turbomachines operating with gas bearings to achieve long life.

As an example of the value of the SBIR program, I would like to describe one of these projects in more detail. Under DOE funding we have developed a generic cryogenic helium pump/compressor capable of meeting a wide range of performance needs. This device has a number of commercial applications not met by any commercial hardware including: a key component in a magnetic refrigeration system for cooling satellite sensors for the Air Force, transfer of cryogens (for example hydrogen) in space for NASA, and cooling superconducting magnets for high energy physics research for DOE. The pump we developed uniquely meets the needs of these applications which include high reliability, long life, maintenance free operation, and, most importantly, non-contamination of the fluid being circulated. We achieved this by hermetically sealing the machine and using the cryogen being circulated as the sole lubricant for the bearings.

The potential benefits of this cryogenic pump to DOE are illustrated by our recent experience testing the Phase II prototype machine at Fermilab. Fermilab conducts high energy physics research. This research involves accelerating particles to extremely high velocities through the use of very large superconducting magnets. The accelerator facility at Fermilab represents an existing investment of over 1 billion dollars. By adding a number of these cryogenic pumps to their facility the energy levels achievable for their high energy physics research could be increased by as much as 25%. This represents an extremely cost effective method to achieve significant performance gains in the worlds' most powerful accelerator and to maintain America's leadership in high energy physics research.

Although in some of our SBIR projects we have established a Phase III funding commitment from a larger firm, we plan to commercialize the results of a number of our SBIR projects ourselves. The cryogenic pump just described is one product where the Phase III funding is being provided by Creare. Using our own funds we have installed one pump for check out at Fermilab. This pump is undergoing a series of demanding performance tests, and we are supporting these tests by adding design features needed by this particular application. I am very pleased that most agencies allow self commitment by the SBIR firm as a valid Phase III commitment under the rules. Some agencies, however, do not accept such self commitment. These agencies who do not are in effect asking a small business that is fully capable of commercializing their innovation to give up some of the downstream potential to another firm. While the use of a self commitment can be abused, and agencies need to assess such self commitments with considerable care, I feel that they should be no less valid than a third party commitment. In the cases where we have negotiated third party commitments, we have typically done so because the results of our project would be merely one component of a larger system. For example, we are developing a cryogenic refrigerator for MRI systems under NIH funding. We have teamed in this case with one of the leading manufacturers of MRI systems.

The SBIR program has benefited Creare in many ways. It has helped seed innovation by allowing us to develop new technology and extend and productize some of our core technology. For example, until we received a Phase I award, Creare had never worked in the area of electromagnetic propulsion. Now, although we are only just beginning our Phase II SBIR project in this area, we are in a sense already in "Phase III". In this case "Phase III" is applying the basic technology we developed during Phase I to perform engineering service contracts for several prime contractors of the Air Force.

As an example of extending and productizing some of our core technology, in the cryogenic area Creare is developing separate products under the SBIR program for five different agencies: DOE (cooling superconducting magnets for high energy physics applications), the Air Force (cryogenically cooled electromagnetic launch devices), NASA (space borne refrigeration systems for cooling telescope optics), the Navy (shipboard liquifiers for nitrogen and oxygen), and NIH (helium liquifiers for MRI systems). Our work in cryogenic turbomachinery under the SBIR program has also assisted us in obtaining a subcontract from the Air Force valued at over 1.5 million dollars to develop a critical component of a three stage refrigeration system for a satellite application.

I believe there is widespread interest in the SBIR program on the part of small innovative firms. This is understandable because it allows small businesses to do what they do best -- the emphasis is on research and innovation rather than selling and marketing. The SBIR program encourages the maximum time and money be spent on idea development and actual research. It is structured to minimize those things which tend to reduce overall research efficiency such as selling, program delays, and excessive reporting requirements. Many small businesses are technically superior but lack finely honed selling abilities. The SBIR program gives them the opportunity to develop their ideas and to do what they do best -- research and development. The emphasis on concise proposals is a tremendous benefit both to the small business and to the agencies involved in the program. I strongly urge the retention, and perhaps even the reduction of the current Phase I proposal page limit.

Creare has received awards from over half of the participating agencies. While our experience with all agencies has been excellent, I would like to acknowledge one in particular -- the Department of Energy. Particularly praise worthy is DOE's establishment of a workable vehicle for timely review of Phase I results and Phase II proposals so that the Phase II research can follow Phase I without a debilitating funding gap. This is very important to many small businesses which critically need funding continuity in their development efforts. I hope other agencies will follow the lead of DOE in the area of funding continuity.

I have extremely high praise for the SBIR program, for the many dedicated individuals who brought it into being, and for those who are currently working so hard to make it as successful as it can be. The Nation as a whole will certainly benefit from the technology advances and the growth in employment opportunities afforded by this program. Since studies have repeatedly shown that small business is the most efficient creator of technological innovation and job opportunities, I believe that the benefits to the Nation will far exceed what they would have been if these research funds were otherwise directed.

A 1973 Battelle Memorial Institute study of important innovations revealed the average time between first conception and first commercial realization was over 19 years. Although benefits to the nation from the SBIR program are already clear, it is obvious that the most significant benefits will not be realized for a number of years. This is one of the many powerful arguments for continuing the program beyond October 1988.

Senator RUDMAN. Thank you very much, Dr. Block.

Dr. Crawford, we are delighted to have you here.

STATEMENT OF DR. CHUCK CRAWFORD, PRESIDENT, KIMBALL PHYSICS, INC., WILTON, NH

Dr. CRAWFORD. Thank you very much.

My name is Chuck Crawford. I am a physicist and president of Kimball Physics down in Wilton. Up until 1974, I was a professor at MIT which, for those in the audience who don't know, is where New Hampshire Governor John Sununu got his degree.

The SBIR program certainly appears to be a worthwhile Government effort and should be continued. However, a serious mismatch between Government accounting practices and the apparent optimum manner of growing a successful high technology manufacturing company, has led Kimball Physics to voluntarily drop out of the program.

We have a few suggestions which might make the program more helpful to other companies in the future, with perhaps a better return to the country as a whole.

Our problems are really not with the SBIR Program of which we strongly approve, but with Government procurement inefficiencies in general.

Kimball Physics is a quite small, about 40-person, manufacturer of electron and ion optics. The company——

Senator RUDMAN. Can you tell us what you do again?

Dr. CRAWFORD. We manufacture electron optics and ion optics, mostly for research applications. They are used in semi-conductor manufacturing, and in several different kinds of analytical instruments. We dominate a market making the high bright electron sources used in scanning electron microscopes.

The company is in excellent financial condition. It has been continuously profitable over the past dozen years. It is growing at about 30 percent a year, and all growth has been from internally generated funds. We don't accept venture capital funds.

The company has invented and brought to market many commercially successful new products. Though we are a manufacturer, we are really in the new idea business.

In January 1985, Kimball Physics submitted responses to two Air Force phase 1 SBIR solicitations. This was our first contact with any SBIR Program. Both proposals were winners. The project involved the design and fabrication of two types of special high power electron guns for use in outer space. There is some relevance to SDI.

It was our belief that there was an industrial market for these types of guns. In fact, we are now booking industrial orders for somewhat similar guns.

Difficulties arose in the summer of 1985 prior to the awarding of the phase 1 contracts when, in the opinion of Kimball Physics, the Air Force failed to follow the procedures set out in the program solicitation book. The difficulties were resolved in large measure by your office, and the projects started around September of 1985.

The Air Force more recently notified Kimball Physics that they would like to have Kimball Physics undertake phase 2 contracts for both these phase 1 projects, which are now nearing completion. After a great deal of soul searching, Kimball Physics has decided to continue the projects, but to decline the phase 2 contracts. The lack of Government funding will substantially slow development, and the Air Force, at least for now, will not obtain the electron guns they desire. However, most of the industrial aspects of the projects remain viable.

The major problem here is fundamental and doesn't really seem to have an obvious solution. It is that the goals, cultures, needs, and accounting systems of these two organizations, ourselves and the Air Force, are completely mismatched. Kimball Physics is organized as a high value added, very low overhead, high gross margin, medium growth business. Our goal is to have top quality products. Our prices are usually lower than the competition.

Human values are stressed, high personal growth, high opportunity, promotion from within, avoidance of conflict, high ethical standards, cooperation, trust, comfortable working conditions, total absence of layoffs, continuous availability of overtime, minimum paperwork, et cetera. We keep our overhead low by the use of old buildings with low rent. We rebuild equipment which has negligible depreciation left, and we have bought the remains of a couple of other companies at very low cost.

The employee reward structure relies heavily on bonuses which relate to innovation, productivity, and most specifically to the results achieved. Mistakes are only rarely punished. We don't expect everything we build to work. People are supposed to do their own thinking, to speak up, to take reasonable risks. Errors are expected, but we try to swamp them with success.

In contrast, the Government procurement system is designed principally to avoid risk, to avoid criticism, to force minimal standards on marginal individuals, and to assume that all possible dishonesties not specifically prevented are going to occur. The Government accounting systems contain substantial incentives for inefficiency and low productivity. Paperwork is sometimes used as a coverup for waste or low competence, and the assumption is made that all errors are bad.

Kimball Physics has refused to go through the Government audit procedures that the Government would like. The reason that Kimball Physics is forced to avoid Government auditing is that Kimball Physics couldn't pass; we would fail. We do not track costs in a manner satisfactory to the Government, and to do so would place an unacceptable burden on our company management structure. Our overhead is one-half to one-third that typical of a more normal Government contractor. Many of the common expenses have been reduced or avoided altogether.

If Kimball Physics were to allow the Government to assign an overhead rate based on our true costs on any large contract, our large gross margins would disappear and with it our capacity for growth out of internally generated funds. Our bonus system which we consider essential to creativity and productivity would clearly be disallowed.

From the Kimball Physics point of view, the real question here is who is going to run the company. Should it be the group which has had the modest success to date, or should it be turned over to a

Government system which is not even able to balance incoming and outgoing cash flows?

Note that if a defective Government management system takes over a small creative organization, the result will not be a small creative Government subunit. The creativity will be gone. All that will be left is more mouths to feed.

There is a lot of creativity which resides in small business. It is worthwhile to remember why. It isn't smallness or bigness per se. It is the enthusiasm, the reward structure, the freedom, and the efficient management systems which frequently exist in small businesses and there are also many inefficient small businesses around. Usually, however, they get autioned off and recycled into the economy fairly rapidly. Unfortunately no similar system for dismantling inefficient Government subunits seems to exist.

In any case, inefficient Government systems should not be allowed to overwhelm efficient small businesses.

In spite of these difficulties described above, many of which relate to a unique situation in our company, the SBIR Program can and should have a very positive effect on innovation and technology in the United States. We strongly support it. The following points may be worth discussing in the hope of making the program even better. These are intended as constructive suggestions, and we certainly are not experts.

No. 1, in comparing experiences with other small company managers, there appears to be a great variability between the methods used by the different agencies in administering the SBIR awards. Assuming the Congress knows what it wants, more staff time should probably be spent watching what is going on. In at least some agencies, the spirit of the SBIR system, as originally espoused and executed by NSF, is not being followed.

No. 2, the balance between reasonable audit needs and destructive accounting interference needs addressing. It may well be that for companies as out of step as Kimball Physics that no suitable compromise exists. However, the Air Force stated to us that their policy is to treat the SBIR awards the same as any other procurement contract, and this is probably not appropriate. It is also probably unwise to allow the use of SBIR awards for pure hardware procurements with no research content at all, as the Air Force inaccurately claimed in the Kimball Physics case.

No. 3, at present, at least in the Air Force, some solicitations are apparently targeted toward specific companies before the solicitation book is even published. This practice would appear to subvert the process of an open competition. At best, it seems unfair to other companies which prepare proposals in good faith but then have little chance of success.

No. 4, there is a real question as to how many awards should be given to any one company. The present lack of any kind of control seems to be fostering the formation of what might be called proposal factories. We are not necessarily in favor of a cap; but the problem should be addressed.

In a proposal factory, the best expertise isn't the technology at hand—nobody can be expert at everything—the expertise is in proposal writing. The interests of innovation, and the country at large, might be better served by spreading awards around into the hands

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of the most technically qualified, even though these organizations may not necessarily write as well, or have friends in the right places.

No. 5, the present solicitation system where the Government agencies specify narrow specific problems to be solved, does have the very desirable effect of focusing creative talent on real and present needs. However, it also has the deleterious effect of ignoring creative solutions to unrecognized problems. A few broader, more open ended problem categories—with meaningful chances of being selected—should be added. Such an addition would not be an easy task because of the judging difficulty, that is, these types of projects would have no assigned sponsors within the various agencies.

No. 6, because of the financial award structure, projects tend to assume a financial size independent of their real cost or worth. The smaller problems puff up and the larger problems scale down to fit available cash; a loss of financial efficiency results. The award structure also assumes the eventual need of some sort of outside financing which many new successful products really don't need. If additional financial flexibility could be included without making the program unmanageable, it would be worthwhile.

No. 7, the best proposals and the best products from any given company are not necessarily being developed by the program in its present form. The SBIR products which Kimball Physics is currently working on are perhaps our fourth or fifth best idea; but we are working on these ideas because the funding is there. The question arises of whether or not the Government should choose, by the addition of dollars, which areas are to be pursued.

Senator **Rudman**. That is a very tough issue, Dr. Crawford, one that we addressed long and hard during our deliberations.

Dr. **Crawford**. It is a very hard one.

No. 8, there is a question about which companies the program should be helping. It may well be that Kimball Physics, with 30 percent per year growth out of internally generated funds and no venture capital, really isn't the company this program should be targeted to.

Finally, and I see my time is up, I would like to make one comment on how the Government should be run as seen from the outside of the system, from the absolute bottom of the pile, looking up. What we really need to address are the unsound Government management systems. If we don't, it is unlikely the size of Government can be controlled, that the efficiency of Government can be restored, or that these terrible hemorrhaging deficits can be staunched. Our collective futures are at stake.

Thank you very much.

[The prepared statement of Dr. Crawford follows:]

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(603) 878-1616

TESTIMONY: Government Funding and the SBIR Program
Merrimack, NH; March 3, 1986

Dr. Chuck Crawford, President
Kimball Physics Inc., Wilton, NH 03086
(603) 878-1616

SYNOPSIS: The SBIR Program appears to be a worthwhile government effort; and should be continued. However, the serious mismatch between government accounting practices, and the apparent optimum manner of growing a highly-successful high-tech manufacturing company, has led Kimball Physics to voluntarily drop out of the program. Some suggestions are made which might make the program more helpful to other companies in the future, with perhaps a better return to the country as a whole. Comments are also made concerning methods of conducting government business in general.

Kimball Physics Inc., is a quite small (about 40 people), growing manufacturer of electron and ion optics. The company is in excellent condition, and has been continuously profitable over the past dozen years. All growth has been from internally generated funds. The company has invented and brought to market many commercially successful new products.

In January 1985, Kimball Physics submitted responses to two Air Force Phase I SBIR Solicitations (this was our first contact with any SBIR program); both proposals were winners. The projects, Air Force # 158 (AFGL/XOP) and # 174 (RADC/DORM), involve the design and fabrication of two types of special electron guns for use in space applications. It was our belief that there is a industrial market for these types of guns; and in fact we are now booking industrial orders for somewhat similar guns.

Difficulties arose in the summer of 1985, prior to the awarding of the Phase I contracts, when in the opinion of Kimball Physics, the Air Force failed to follow the procedures set out in P.L. 97-219 as decribed in the DOD Program Solicitation Book Number 85.1 Dated 1 October 1984. The difficulties are described in the attached letters, and were resolved by September 1985.

The Air Force has notified Kimball Physics that the Air Force would like to have Kimball Physics undertake Phase II contracts for both these Phase I projects (now nearing completion). After much soul-searching, Kimball Physics has decided to continue the projects, but to decline the Phase II contracts. The lack of government funding will substantially slow the development, and the Air Force will not (at least for now) obtain the hardware they desire. However the industrial aspects of the projects remain viable.

The major problem here is fundamental, and has no obvious solution. It is not related to inappropriate behavior of government officials; nor is it related to any unwise prudishness regarding financial information by Kimball Physics. The problem is that the goals, cultures, needs, and accounting systems of these two organizations are completely mismatched.

Kimball Physics is organized as a high-value-added, very-low-overhead, high-gross-margin, medium-growth business. Innovative top quality products, at a fair price (no higher than the best alternative), is the market strategy. Human values are stressed: high personal growth, high opportunity, promotion from within, avoidance of conflict, high ethical standards, cooperation, trust, comfortable working conditions, total absence of layoffs, continuous availability of overtime, minimum paperwork, etc. Overhead is low due to the use of old buildings with low rent, rebuilt equipment with negligible depreciation, and parts of other companies bought at very low cost. The employee reward structure relies heavily on bonuses, which relate to innovation, productivity, and results achieved. Mistakes are only rarely punished; we do not expect everything we build to work. Everyone is supposed to do their own thinking, to speak up, and to take reasonable risks. Errors are anticipated, but we try to swamp them with success.

In contrast, government procurement systems are designed principally for risk avoidance, criticism avoidance, to force minimal standards on marginal individuals, and with the assumption that all possible dishonesties not specifically prevented will occur. Government accounting systems contain substantial disincentives against efficiency and productivity. Paperwork is often a coverup for waste and low competence. The assumption is that all errors are bad.

The reason that Kimball Physics is forced to avoid government auditing, is that Kimball Physics could not pass. We do not track costs in a manner satisfactory to the government, and to do so would place a unacceptable burden on the company management structure. Our overhead is one-half to one-third that typical for a more normal government contractor; many of the common expenses have been reduced or avoided. However, if Kimball Physics were to allow the government to assign a true overhead rate on any large contract, our large gross margins would disappear, and with it our capacity for growth out of internally generated funds. Our bonus system, essential to the creatvity and productivity of the organization, would clearly be disallowed.

From the Kimball Physics point of view, the real question is who is going to run this company? Should it be the group which has had the modest successes to date, or should it be turned over to a government system which is not even been able balance incoming and outgoing cash flows. Note that if a defective government management system takes over a small creative organization, the result will not be a small creative government subgroup. The creativity will be gone; all that is left will be more mouths to feed.

In spite of the difficulties described above, some of which may relate to a partially unique situation, the SBIR Program can and should have a positive effect on innovation and technology in the United States. The following points may be worth discussing, in the hope of making the program more effective in the future.

(1) In comparing experiences with other small company managers, there appears to be great variability between the methods used by various agencies in administrating SBIR awards. Assuming that the Congress knows what it desires the program to be, more staff time should probably be spent watching what is going on.

(2) The balance between reasonable audit needs and distructive accounting interference needs addressing. It may well be that for companies as out of step as Kimball Physics, that no suitable compromise exists. However the Air Force stated policy to treat SBIR awards "the same as any other procurement contract" does not seem appropriate. It is also probably unwise to allow the use of SBIR awards for pure hardware procurements with no research content, as the Air Force (inaccurately) claimed in the Kimball Physics case.

(3) At present, at least in the Air Force, some solicitations are apparently targeted toward specific companies before the solicitation book is even published. This practice would appear to subvert the process of an open competition. At best it seems unfair to other companies, which prepare proposals in good faith, but which have little chance of success.

(4) There is a real question as to how many awards should be given to any one company. The present lack of any control or limit seems to be fostering the formation of what might be called "proposal factories", where the best expertise is not the technology at hand, but rather in proposal writing. The interests of innovation, and of the country at large, might be better served by spreading awards around into the hands of the most technically qualified, even though they may not write as well, or have friends in the right places.

(5) The present solicitation system, where the government agencies specify narrow specific problems to be solved, does have the desired effect of focusing creative talent on real and present needs. However, it also has the deleterious effect of ignoring creative solutions to unrecognised problems. A few broader, more open ended problem categories, with meaningful chances of being selected, are needed. This will not be an easy task, because of the difficulty in judging, and because these types of problems have no assigned sponsors within the various agencies.

(6) The award financial structure tends to assume a specific size of problem and/or product development. The immediate tendency is that smaller problems puff up, and larger problems scale down, to fit the available window; a loss of financial efficiency thus results. The award structure also assumes the ultimate need of some sort of outside financing, which many new useful products in this size range really don't need. If additional flexibility could be included, without making the program unmanageable, it would be worthwhile.

What follows is a few (perhaps out of place) comments about how governments should be run, as seen from the outside of the absolute bottom of the pile, looking up.

A basic tenant of capitalistic systems is that innovation, productivity, efficiency, good judgement, and such like, are to be rewarded. Implicit with this tenent is the corollary that individuals are to be rewarded according to the specific results which they themselves achieve.

Why is it then, that our American Government (government of the largest capitalistic country extant to date), wishes to reward both its own employees, and most of its suppliers, according to the alleged effort expended, rather than acccording to results achieved? Of course there is enormous ineffciency; this procedure guarentees it.

Internally, our government system is destroying its own best employees. While there are many good people in government; the system doesn't trust them, risk taking is not allowed, mediocrity is assumed. The proper way would be to hire honest, competent people, to trust them, to give them the authority needed to get the job done, and then expect good performance. In the rare cases where the trust is breeched, take strong action. People must be rewarded according to the results they achieve.

Externally, the government is the largest purchaser of goods and services. But the widely used cost-plus-fixed-fee contract system is ruining the high technology base of our economy. There are few efficiency incentives here, only incentives for failure and waste. In most cases of large cost overruns, the government is the victim of its own folly. The damage is not limited to government contractors alone, it spills over into our society as a whole. It isn't the Japaneese that are doing this to us, we are doing it to ourselves.

Without some kind of reform of our unsound government management systems, it is most unlikely that the size of government can be controlled, that the efficiency of government can be restored, or that these terrible hemorrhaging deficits can be staunched. Our collective futures are at stake.

Senator RUDMAN. Thank you, Dr. Crawford.

I would just make an observation. Back during the summer, you wrote to our office very unhappy with the audit procedures that were going to be required. Then, you said in your letter, as I recall, you wouldn't be surprised if I agreed with the agency. I, of course, didn't agree with the agency; I agreed with you on this case. My understanding is that Will Taft, the Deputy Under Secretary of Defense, did respond, and things did work out, at least in the short term. But my understanding is when it came to phase 2 awards which you could have received a total of somewhere slightly under $500,000, you decided not to go ahead with those because of the audit procedures. Is that correct?

Dr. CRAWFORD. That is correct. And we do understand that this is a pretty strong position to take given the size of our company, and the fact that we plan to continue development of the products.

Senator RUDMAN. Well, let me just say that we will look at the issue. It is a tough issue to look at. You have $2,000 step ladders and $3,000 coffee pots and $700 transistor chips, the normal tendency for those who are on the receiving end of those assaults which come from the Congress and the media is to immediately buttress the audit procedure in such a way that it can't happen.

Yet, there is no question that the audit procedure for highly innovative small companies cannot be so cumbersome as to discourage them, as it did you, or to make their overheads more like large companies by putting audit systems into place that are very costly.

So, we are aware of the problem, and we would like to fix it. Whether we can or not remains to be seen.

I want to thank all three of you for testifying here. I have asked you questions as we have gone along, and I appreciate your taking the time.

We are going to take a 5-minute break to give our stenographer and others a chance to just stretch a bit, and then we will resume just before 11.

[Recess.]

Senator RUDMAN. We will come back to order, and if we could have the last panel: Mr. Levine, Mr. Williams, and Mr. Howe.

Gentlemen, we thank you very much for being with us this morning. I would like you again to limit your testimony, if you can, to the time that we have allotted. To the extent that you have full statements, they will be incorporated in the record. We will start with Mr. Howe.

STATEMENT OF ROBERT E. HOWE, PRESIDENT, PHOTOFABRICATION TECHNOLOGY, INC., DERRY, NH

Mr. HOWE. Thank you.

Senator, I am pleased to have this opportunity to provide you with comments on my experience with the SBIR Program and to express my appreciation for both your involvement in the program and your interest in its continuation.

Photofabrication Technology, Inc. [PTI] is a small high technology manufacturer located in Derry, NH. This process, photofabrication, is one of the most widely utilized in the electronics industry. It has enabled the production of components ranging in complexity from low-cost automotive printed wiring to the most sophisticated VHSIC or gallium arsenide integrated circuits. It includes microwave, electro-optics, and virtually the entire printed circuit industry.

PTI employees this process in only a portion of this range of applications. We design and produce a variety of electronic components for instrumentation, aerospace, and military applications.

About 4 years ago, after a number of years in primarily R&D activities, I decided to pursue commercial applications for many of these processes that we had developed. As a result, our business has nearly tripled in the past 2 years. With about 60 employees, we are shipping product at a rate of about $3.5 million per year. Most of these components are aerospace associated such as precision multilayer flexible circuits.

Because of our focus on the process capabilities rather than the specific products, PTI has been able to transfer technology from cryogenic sensors, nuclear powerplant probes, and electronic scales at checkout counters to the Strategic Defense Initiative Program now known as star wars and special circuits for the Trident system.

When the SBIR Program was announced, I saw it as an opportunity which fit well with my goals to creatively apply our technology to a host of new and challenging applications. Our background in strain gages, resistor networks, precision heaters, satellite and space shuttle electronics, and flexible printed circuits for electro-optic systems enabled me to submit eight proposals in 1983, the first year of the program. We were successful on one, and that was to develop a special sensor for monitoring the effects of acid rain.

We have submitted five to eight proposals each year since then. We received a second phase 1 contract for a different type of device and then a phase 2 contract for the special sensors in our original phase 1 research. I have yet to hear on all the proposals submitted last year, but I am hopeful that our success will continue.

The SBIR Program is providing us with an important opportunity to strengthen our business in the instrumentation field by developing a product that we feel may become a very important tool for both Government and business.

To provide you with a little more detail on the phase 2 contract, PTI is to demonstrate a specific application of these new sensors which can provide information on both the cumulative and instantaneous structural damage resulting from a corrosive environment such as acid rain or road salt. We have a $320,000 phase 2 contract with which to refine the sensor and the associated electronics and to conduct an extensive test program over 29 months. If successful, I believe that the sensors could save taxpayers and industry hundreds of millions of dollars in just a few years.

Without the SBIR Program, the exciting prospects for these new devices would still be at the feasibility stage or perhaps still only on paper.

However, one aspect of doing business with the Government has been a disappointment. The redtape and nuisance factor for receiving payments has been very significant. For example, PTI requested and received approval for progress payments for the first Air Force phase 1 contract. We did not receive the first progress payment until the contract was almost finished. The last progress payment was received in November 1984, 4 months after the final report was submitted.

Next, the solicitation has provisions for interim funding if a phase 2 proposal was submitted before a certain deadline. We met that deadline, but the interim funding was not operative. That is, the DAR, the Defense Acquisition Register, which was operative at that point in time did not direct the procurement officer to interpret the solicitation as superseding the normal procedures.

In fact, the phase 2 award was not released until last September, 1½ years after completion of the phase 1 contract. Currently, the progress payments for the phase 2 contract have been delayed because PTI was unaware of a special form, form No. 1443, that was necessary in order to get progress payments.

Under a separate U.S. Navy phase 1 contract, PTI was denied progress payments altogether for the 6-month contract period because the procurement officer read the FAR which superceded the DAR to prohibit such payments for contracts under $100,000. We received payment in December 1985, about 6 months after the July 1985 final billing, one year after we started work on the job.

In all of these cases, funds were held up at each approval point by a minor technicality or a missing item of paperwork not previously explained to us. Clearly, these are not SBIR problems but PTI's inexperience with the proper preparation of the necessary paperwork.

Senator, in closing, I have two major observations. First, the competition for contracts is very fierce and many excellent innovations go unfunded. If the experience of other companies is similar to mine, there is very little followup from anyone in the Government or the private sector on unfunded proposals. If one of the goals of the SBIR Program is to increase the circulation of innovative concepts in the business community, then some means to better disseminate these ideas would be in order and would very likely have positive results since only several hundred of the 8,000 to 10,000 proposals are awarded contracts.

Second, if the real goal is to enable the United States to regain international leadership in patents, innovation, and new product development by tapping the creative juices of individuals as well as the existing small business community, then the payment problems that I have experienced is a major obstacle. Access to the bright minds of individuals who have creative ideas but cannot afford to leave their full-time jobs as is required in the solicitation cannot be gained unless help or reduction of the redtape for the few hundred contract recipients is developed.

Clearly, those of us who already have established small businesses and can survive the delays would welcome that specific type of administrative help as well.

The only other comments I would add to the written testimony that I have already provided really are to reiterate the issues of the long delay between phase 1 and phase 2 contracts and the Draconian accounting procedures that exist as far as doing business with the Government. I think that there are a large number of potentially very beneficial innovations and concepts of individuals at large companies or small who would like to be in a position to pursue those but for reasons very much akin to those expressed by Dr. Crawford aren't able to do so under the program.

I would also like to express my absolute belief in the program, not only as a recipient but as a member of the U.S. business community very anxious for us to regain our position of stature in the world economy.

I wish to thank you for this opportunity to share my experience and belief in the program, and I welcome any questions that you have.

[The prepared statement of Mr. Howe follows:]

PHOTOFABRICATION TECHNOLOGY INC Century Building P O Box 3209 Derry N H 03038 Phone 603 432 1200

CR-2-172-86

U.S. Senate
Re: Oversight hearing on the SBIR Program

March 3, 1966

Robert E. Howe, President
Photofabrication Technology, Inc
Box 3209
Derry, NH 03053

Honorable Members of the Committee:

I am pleased to have this opportunity to provide you with comments on my experience with the SBIR Program, and to express both my appreciation for your involvement in the program and your interest in its continuation.

Photofabrication Technology, Incorporated (PTI), is a small high-tech manufacturer located in Derry, New Hampshire. Photofabrication as a manufacturing process is one of the most widely utilized in the electronics industry. It has enabled the production of components ranging in complexity from low-cost automotive printed wiring to the most sophisticated VHSIC or Gallium Arsenide (GaAs) integrated circuits, and includes microwave, electro-optics, and virtually the entire printed circuit industry. PTI employs this process in only a portion of this range of applications. We design and produce a variety of electronic components for instrumentation, aerospace, and military applications.

About four years ago I decided to pursue commercial applications for many of the processes developed in our R&D efforts. As a result, our business has nearly tripled in the past two years, and with about 60 employees we are shipping product at a rate of about $3.5MM per year, mostly in aerospace components such as precision multilayer flexible circuits.

Because of our focus on the process capabilities rather than specific products, PTI has been able to transfer technology from cryogenic sensors, nuclear power plant probes, and electronic scales at check-out registers to the Strategic Defense Initiative program now known as "Star Wars" and special circuits for the Trident system.

When the SBIR program was announced, I saw it as an opportunity which fit well with my goals to creatively apply our technology to a host of new and challenging applications. Because of our background in strain gages, resistor networks, precision heaters, satellite and Space Shuttle electronics, and flexible printed circuits for electro-optic systems, I submitted 8 proposals in 1983, the first year of the program. We were successful on one, to develop special sensors for monitoring effects of acid rain. We have submitted 5 to 8 proposals each year since then. We received a second Phase I contract for a different device, then a Phase II for the special sensors. I have yet to hear on all the proposals submitted last year, but I am hopeful that our success will continue. The SBIR Program is providing us with an important opportunity to strengthen our foundation in the instrumentation field while developing a device that we feel may become a very important tool for both government and business.

To provide you with a little more detail on the Phase II contract, PTI is to demonstrate a specific application of these new sensors, which can provide information on both the cumulative and instantaneous structural damage resulting from corrosive environments such as acid rain. We have $320K with which to refine the sensor and associated electronic designs, and conduct an extensive test program over twenty nine months. If successful, I believe that the sensors could save taxpayers and industry hundreds of millions of dollars in just a few years. Without the SBIR Program, the exciting prospects for these new devices would still be at the feasibility stage--or perhaps still only on paper.

However, one aspect of doing business with the government has been a disappointment. The red tape and nusiance factor for receiving payments has been very significant. For example, PTI requested and received approval for progress payments for the first Air Force Phase I contract. We did not receive the first progress payment until the contract was nearly complete. The last "progress payment" was received in November 1984, fouf months after the last revision to the Final Report was submitted. Next, the Solicitation has provisions for interim funding if a Phase II proposal were submitted before a certain deadline. We met that deadline, but interim funding was not "operative". That is, the DAR did not direct the procurement officer to interpret the Solicitation as superseding the normal procedures. In fact, the Phase II award was not released until last September, 1 1/2 years after completion of the Phase I contract. Finally, the progress payments for the Phase II contract have been delayed because PTI was unaware that a special form (1443) was required.

Under a separate US Navy Phase I contract, PTI was denied progress payments altogether for the six month contract period because the procurement officer read the FAR to prohibit such payments for contracts under $100,000. This payment was received in December 1985, about 6 months after the July 1985 final billing. In all of these cases, funds were held up at each approval point by a minor technicality or missing item of paperwork not previously explained to us. Clearly, these are not SBIR problems, but PTI's inexperience with the proper preparation of the necessary paperwork so that we could obtain payments in a timely fashion.

Gentlemen, in closing, I have two major observations. First, the competition for contracts is very fierce, and many excellent innovations go unfunded. If the experience of other companies is similar to mine, there is very little follow-up from anyone, government or private sector, on unfunded proposals. If one of the goals of the SBIR program is to increase the circulation of innovative concepts in the business community of the United States, then some means to better disseminate these ideas would be in order, and would very likely have positive results since only several hundred of the 8 to 10 thousand proposals are awarded contracts. Second, if the real goal is to enable the United States to regain international leadership in patents, innovation, and new product development by tapping the creative juices of individuals as well as the existing small business community, then the payment problems I have experienced is a major obstacle. Access to the bright minds of individuals who have creative ideas but cannot afford to leave their full-time jobs, (as is required in the Solicitation), cannot be gained unless help or reduction of the red tape for the few hundred contract recipients is developed. Clearly, those of us who already have an established small business and can survive the delays would welcome that specific type of administrative help, as well.

I wish to thank you for this opportunity to share my experiences and belief in the program, and I would welcome any questions you may have.

Very truly yours,

RFHowe

R. F. Howe
President

Senator **Rudman**. Mr. Howe, thank you very much.

I want to make an observation to you and to the panel and for the record.

One of the things that we were very concerned about after listening to testimony back in 1981 was that if this program had too much funding too early and there was not great care and greatly intense competition for each grant, we well could kill the goose that laid the golden egg. In other words, we would get out there 2 and 3 years and start having a number of horror stories of how grants were made and that they were poorly spent.

So, we decided to have an incremental process within the program which, I believe, is working. Because what is happening is that, number one, the agencies are becoming accustomed to at least how to make the grants, although I would agree there are some accounting and follow-through problems, but just for the record, you might be interested.

In 1983, the range was $30 to $50 million. In 1984, it was $100 to $150 million. In 1985, it was $170 to $250 million. In 1986, it was $250 to $400 million, and in 1987, it will be in the range of $275 to $450 million, close to $.5 billion of existing funds. So, although the competition will remain fierce because the number of entrepreneurial high technology companies is increasing, nonetheless, there is going to be much more money available for these programs.

That is by design, because one of the problems that you can have with a Government program like this is if your critics find enough horror stories early on, then you are apt to lose it all.

As far as your comments about accounting and the bureaucracy, I am glad to hear them. We are going to have to address them. I am not sure quite how because of the nature of the problem.

Mr. **Howe**. I think that with the limited number of people that are successfully participating, the task of assisting them in preparation of the materials and understanding their responsibilities isn't an overwhelming job at all, whether it is done at the State level or some kind of local level. It seems to me that is an unnecessary hindrance in the successful application of the program that isn't overwhelming in terms of its enormity. Certainly, to do that for everyone who submits a proposal would be an overwhelming task, but——

Senator **Rudman**. Of course, the Small Business Administration does have general oversight of this and, of course, as many know, that is in the President's budget for elimination. I am not really sure that is going to happen, but obviously within the resources available, it is conceivable that we might get more help from local State SBA offices to help small businesses although, quite frankly, the help ought to come from the agencies themselves.

So, we will look at that problem.

Mr. **Howe**. I think small businesses such as mine can withstand those difficulties. I think it is very difficult for an individual who has a brilliant concept to do so, though.

Senator **Rudman**. Thank you.

Mr. Williams.

STATEMENT OF JOHN H. WILLIAMS, PRESIDENT, PRACTICAL DESIGN LABS, NASHUA, NH

Mr. **Williams**. Good morning, Senator and members of the subcommittee.

I am John Williams, president of Practical Design Labs. PDL was established in 1976 and was the recipient of a phase 1 but not a phase 2. Our original project was entitled "Intelligent Manufacturing Systems for Surface Mount Technology."

What I would like to do is to review the steps PDL took prior to, during the SBIR, and after our involvement with the SBIR to show the kinds of things that we did, only a part of which was the SBIR.

I began work on alternate approaches in electronic manufacturing with the intention of finding an effective means of reducing the cost disparity between U.S. and foreign manufacturing. That was in the summer of 1982.

In the fall of 1982, I developed our first business plan to reach these goals. I had approached several people whom I knew in the area and asked if they would review them for a sanity check. Generally, they came back negative. They said it just wasn't going to happen, they couldn't see how it was going to work, or how we could reestablish our position on a global basis in manufacturing.

Part of the problem was the fact that we had concentrated on the military performance criteria as being the initial step to getting to the long-term goals. This wasn't received very well.

In the winter of 1983, several projects were proposed between PDL and prime or subcontractors to develop this as a coventure between the two companies. These proposals had limited success but did generate a considerable amount of interest. A plan of execution and equipment sketches were presented to a group responsible for factory automation at Hanscom Air Force Base. The enthusiasm was once again encouraging, but we couldn't find a method to fund the work.

In the spring of 1983 and the summer of 1983, I attended DOD conferences on the state of our global manufacturing industries and what the Government was doing in the process to aid the private sector. While enlightening, this wasn't useful in securing a contract either. But during that period, I had learned of the SBIR Program and found one category where our work would fit. After acquiring background information which was available through DTIC-DTIS, we formulated a plan which looked like it didn't overlap the work that had been done previously, and we submitted that proposal to the Air Force.

In the fall of 1983, PDL was awarded a phase 1 contract to proceed with the project.

In the spring of 1984, a preliminary report was developed by month 4 and the final report was delivered on time by month 6. This initiated a new search for venture capital and the completion of a phase 2 proposal.

Everyone has mentioned problems about interim funding and they were here, too.

In the summer of 1984, we received encouragement from the venture community and some interest in funding phase 3, but we did not receive any venture funding.

In the fall of 1984, PDL was notified we had not been selected as a phase 2 award winner, but at this point, surface mount technology was beginning to create its own interest in the private sector and in the military as well. During this period, the Navy, whom I had been talking to quite a bit, had some real interest in this. They created a program which focused on the issues which had been raised in phase 1 and expanded them. We were told by the Air Force that no manufacturing technology issues would be addressed by the SBIR program. That was it.

After several months of work, we received permission to have our originally Air Force funded project transferred to the Navy because they had a real incentive to pursue the work. By the time the project got there, there was no SBIR funds left. It was the end of a fiscal year. There was nothing we could do. We spent 3 months trying to get that decision, and it didn't work.

In the winter of 1985, we had once again solicited prime and subcontractors aware of their mission in pursuit of once again a larger factory automation project. In this timeframe, over $350 million had been additionally funded for manufacturing technology; $200 million or somewhere around there was specifically targeting something called VHSIC technology insertion which was the area that we were pursuing.

Despite our best efforts, no contractor would grant us the opportunity to execute what we had started.

In the spring of 1985, I developed several other ideas which had a smaller scope than the original but could not find private resources to execute them

In the summer of 1985, the numbers had taken their toll. We had been at this thing for over 3 years and hadn't really gotten very far. I had exhausted every avenue of opportunity and had fallen short. By now, the advantages of surface mount technology had been revealed and the private sector had won. They had beaten the thing down, and now it was becoming mediocrity.

Currently, this area is now slated for significant expansion and the prime and subcontractors of the military are extolling its virtues and how it will revitalize our industrial electronics sector. The market for SMT assemblers is now estimated at over $125 million while in 1982 the market did not clearly exist. People looked at it and said no one has ever sold one of these before.

In summary, these were the steps that PDL pursued through this timeframe. The mechanisms that are being offered now are not even close to what we were trying to pursue at that point in time. From the inception, our machines would have impacted the electronics manufacturing environment in the same way that the jet impacted the prop driven airframe market.

No currently designed or proposed piece of equipment more elegantly suits the batch manufacturing needs of the military or small commercial manufacturers. This is still true.

After phase 1, PDL distributed over 75 of its phase 1 reports to developers of factory automation projects. This is well beyond our direct requirement to only support the Air Force. We went out and actively told people what we were doing and what it really meant.

This served a twofold purpose, first as a sales tool for prospective customers and it also was used by prime and subcontractors which aided their formulation of subsequent proposals which were targeted at mission system based manufacturing.

Altogether too often, the safe method of proceeding was a constant theme. This trait was apparent in both the private and military sector. In our project, I had hoped it would not be an issue, but my suspicions are that it was. It seems that they would rather slaughter the cow today for the a hamburger rather than wait the gestation cycle for a new calf tomorrow.

The recommendations I am making for this committee are: the elimination of the profit motivation of both phase 1 and phase 2. I can assure you on phase 3 if funded by the private sector, you won't find investors that want to contribute to the bottom-line profit of an organization. If this is considered a seed funding type of project, then eliminate profit, and if someone wants to get profit, have them do it through direct unsolicited proposals.

Open the manufacturing technology areas to small business. This is not the private domain of large companies.

No company should be allowed to submit proposals in more than three categories. Any company in the SBIR should be focused on a target and not use bird shot or laws of probability to support their efforts. They may, however, submit as many proposals as they wish in each category. In phase 1, PDL submitted two proposals under one category. One concentrated on the top down approach while the other concentrated on a bottom up. Others may be reasonable depending on the science. There may be more than three or four or five ways to try to skin this cat depending on the approach you use determines what the results will be.

No company should participate in more than one phase 2 award. The venture community will not support an organization which has two heads. Why should the SBIR?

Any recipient can comment on the break in service or accounting issues, but if the SBIR does not meet its basic goals, the entire effort will be meaningless. Even if we get the money there when everyone wants it, if we don't hit the nail, forget it.

The basic element of risk which resides at the core of technological advance seems diametrically opposed to the decisionmaking process found in both Government and private organizations. The further and more often one sticks their neck out, the more likely they will lose their head. This issue needs attention throughout the SBIR.

I am pleased to have been involved with an SBIR Program despite our outcome and have recommended it to others who feel they have a contribution which may find both military and commercial use. The experience has been quite rewarding, if not in the monetary sense, at least in the attempt. We did try, we honestly tried, we failed, and I am satisfied.

I sincerely wish all those who undertake this endeavor the best of fortune and hope the program can continue to service the needs of both the private and the public sectors.

Thank you.

[The prepared statement of Mr. Williams follows:]

Senator Rudman
and Members of the Subcommittee

I am John H. Williams, President of Practical Design Labs. PDL was established in 1976 and was the recipient of a Phase I SBIR but not a Phase II winner. Our project was titled Intelligent Manufacturing Systems for Surface Mount Technology.

I would like to review the steps that I pursued prior to, during and after our involvement with the SBIR and conclude with a summary of recommendations.

Summer 1982

I began work on alternate approaches in electronic manufacturing with the intention of finding an effective means of reducing the cost disparity between U.S. and foreign manufacturing.

Fall 1982

I developed our first business plan to reach those goals. This plan centered on the use of Surface Mount Technology in an automated environment. Subsequently, I approached several businessmen and asked if they would review my plan for a sanity check. These individuals included some of the fathers of several successful New England start-ups. The feedback I received was generally negative. At issue was our prospective customer list. The plan focused on military prime and subcontractors as our initial customers. The venture community perceived this list as a liability, rather than an asset.

Winter 1983

Several projects were proposed between PDL and prime or subcontractors to develop this as a coventure. These proposals had limited success but did generate a considerable amount of interest. A plan of execution and equipment sketches were presented to the group responsible for factory automation at Harscom A.F.Base. The enthusiasm was encouraging but we could not find a method to fund the work.

Spring - Summer 1983

I attended several D.O.D. conferences on the state of our manufacturing industries and what the Government was doing to aid the private sector. While enlightening, this was not useful in securing a contract. I learned of the SBIR program and had found one category where our work would fit. After acquiring background information and formulating a plan I submitted a proposal to the Air Force.

Fall 1983

PDL was awarded a Phase I contract to proceed with the project.

Spring 1984

A preliminary report was developed by month 4 and the final report was delivered by month 6. This initiated a new search for venture capital and the completion of a Phase II proposal.

Summer 1984

We received encouragement from the venture community and some interest in funding Phase III but did not receive any funds.

Fall 1984

PDL was notified that we had not been selected as a Phase II award winner. At this point, Surface Mount Technology was beginning to create interest in both the military and private sectors. Also the Navy created a program which focused on the issues we raised in Phase I and expanded on them. We were told that no manufacturing technology issues would be addresses by the SBIR program in the Air Force. After several months of work we received permission to have our project transferred from the Air Force to the Navy if the Navy had a means of funding the work. By the time this determination was made the Navy had committed it's SBIR resources and we were not able to participate.

Winter 1985

PDL had by this time made many prime and subcontractors aware of it's mission and pursued once again a relationship under a larger factory automation project. Navy employees had given us the outlines of the work which would be pursued. Despite our best efforts no contractor would grant us the opportunity to execute what we had started.

Spring 1985

I developed several other ideas which had a smaller scope than the original but could not find private resources to execute them.

Summer 1985

The numbers had finally taken their toll. I had exhausted every avenue of opportunity and had fallen short. By now the advantages of Surface Mount Technology had been revealed and the private sector had won. Currently this area is now slated for significant expansion and the prime and subcontractors of the military are extolling it's virtues and how it will revitalize our industrial electronics sector. The market for SMT assemblers is now estimated at over $125 million while in 1982 this market did not clearly exist.

Summary

These were the steps PDL pursued to see an idea come to market. The mechanisms presently being offered are merely a shadow of what should have been. Our machines from the inception would have impacted the electronics manufacturing environment in the same way the jet impacted the prop driven air frame market. No currently designed or proposed piece of equipment more elegantly suits the batch manufacturing needs of the military or small commercial manufacturers

After Phase I, PDL distributed over 75 of the Phase I reports to developers of factory automation projects. This served a two fold purpose. First as a sales tool for prospective customers such as prime and subcontractors and also aided in their formulation of subsequent proposals which were targeted at mission system based manufacturing programs.

Altogether too often the safe method of proceeding was a constant theme. This trait was apparent in both the private and military sector. In our project I had hoped it would not be an issue but my suspicions are that it was. It seems they would rather slaughter the cow today for a hamburger rather than wait the gestation cycle for a new calf tomorrow.

Recommendations for the SBIR review panel

1. Eliminate the profit motivation of both Phase I and II. I can assure you that if Phase III is funded in the private sector the company will not expect the investor to be the contributor of profit.
2. Open the manufacturing technology areas to small business. This area is not the private domain of large companies.
3. No company should be allowed to submit proposals in more than 3 categories. Any company in the SBIR should be focused on a target and not use bird shot or laws of probability to support their efforts. They may, however, submit as many proposals as they wish in each category. In Phase I, PDL submitted 2 proposals under 1 category. One concentrated on the top down approach while the other offered a bottom up approach. Others may be reasonable depending on the science.
4. No company should participate in more than one Phase II award. The venture community will not support an organization which has 2 heads, why should the SBIR.

Any recipient can comment on the break in service or accounting issues but if the SBIR does not meet it's basic goals, the entire effort will be meaningless

The base element of risk which resides at the core of technological advance seems diametrically opposed to the decision making process found in both government and private organizations. The further and more often one sticks their neck out the more likely they will lose their head. This issue needs attention throughout the SBIR program.

I am pleased to have been involved in the SBIR program despite our outcome and have recommended it to others who feel they have a contribution which may find both military and commercial use. The experience has been quite rewarding, if not in the monetary sense, at least in the attempt. We tried, we failed, but at least we tried like heck.

I sincerely wish all who undertake this endeavor the best of fortune and hope the program can continue to service the needs of both the private and public sectors.

Thank You
John H. Williams

Senator **Rudman**. Thank you, Mr. Williams.

One of the problems you obviously ran into was that what you were trying to do did not fit very neatly into almost any area of solicitation of any department. I am not saying that is right or wrong. It is just that for some reason you did not take this very specialized area that you are speaking of—and I am familiar with what you did and would be technology—nobody in the Government seemed to put that high on their list of priorities or, if they did, they didn't think a small company would be able to do it.

It seems as though that is the problem.

Mr. **Williams**. Oh, there is no doubt they don't believe a small company could do it. I am absolutely certain that they are convinced. You know, if a small outfit fails, then they have the wrong team. If General Electric fails, then it was impossible.

Senator **Rudman**. That is the kind of thing that we run into.

But we are glad to have your testimony. One of the problems that we had from the beginning was how to cast this net, and we had to be kind of careful not to just allow anybody who wanted Government money for any kind of research to come and be eligible. If you did that, I can guarantee you we would have a lot of horror stories.

Mr. Levine, we are glad to have you here. Mark Levine is presently director of corporate development of GEO-CENTERS in Suitland, MD, but I know him best as a former staff member of the House Subcommittee on Innovation and Technology of the House Small Business Committee. And he was very helpful to us when this bill worked through the House.

We are glad to see you have decided to leave the Government and go out and make it happen. Welcome.

STATEMENT OF MARK J. LEVINE, DIRECTOR OF CORPORATE DEVELOPMENT, GEO-CENTERS, INC., NEWTON, MA

Mr. **Levine**. Thank you very much, Senator.

I think I speak for the small business community in telling you that we believe SBIR is the bill that really made you famous, and we appreciate the work that you have done in being an advocate for small business in America.

I am here representing my employer, GEO-CENTERS, and its president and founder, Dr. Edward Marram. GEO-CENTERS is an Inc. Magazine 500 firm, a designation given to the fastest growing privately held companies in America. We employ 175 people in 4 offices in the country. Our growth rate in revenues and employment has more than doubled in the past 2 years, and we have increased tenfold since 1980.

We have been a successful participant in the Federal Government's SBIR Program. We have won several phase 1 awards, and have been awarded three phase 2 contracts. We hope to win two more phase 2 awards in the spring. Although our SBIR work is not our most significant source of revenue, we feel that the program is of tremendous importance to our company and other innovative small businesses.

Our company has extensive experience in the fields of fiber optics, chemistry, combustion, and biomolecular engineering. We have developed a unique capability in the area of fiber optic sensors which is the area we have tended to concentrate our SBIR activity.

I have outlined in my prepared testimony some of the specific areas in which we have won phase 1 and phase 2 awards. In going over material while preparing for this hearing, I thought it would be important if we looked back at some of the reasons the SBIR Program was passed in the first place in order to analyze the program's progress.

Presently in America, we are witnessing a disturbing trend in our economy. Business activity has shifted away from individuals and toward large organizations. For the first time in our history, the share of gross national product held by big business has passed that held by small business. Economists are predicting that by the year 2000, big business activity will be 50 percent more than small business activity.

This is of great concern because of the nature of the ownership of large firms in America. Industrial America tends to be owned by the investment banker and the institutional investor. Our vast and growing system of bankers and professional stock traders seek to rearrange America's assets rather than to enlarge them. We have become a nation of pie slicers rather than pie enlargers, as a professor from Harvard once told us.

Their interest is not in developing new assets or new products, modernizing plant and equipment, or nurturing innovation. Pieslicers seek to diversify their investments, stabilize their profit, and minimize their risks, not take them.

Now, if you look at some of the employment categories in the United States, you will see how this is happening. The Bureau of Labor Statistics charts job trends in the United States. In an employment category called eating and drinking places, the increase in employment in the last 10 years is greater than the total employment in the automobile and steel industries combined. The demand for engineers in our country only increased by 3 percent in the 1970's while the number of managers and administrators grew by 58 percent, health administrators by 118 percent, and bankers by 83 percent. In the 1980's, the demand for paralegal personnel will grow by 109 percent.

That means our economy just does not have the tools available for technology transfer. The research we do in this country—and, believe me, our company does its share; we built a company of almost 200 people doing research for the Federal Government—is the best in the world. It is far superior to what is done in any other country, but the problem is we don't have the tools within our economy to transfer the technology from the research stage into the product development stage.

Government funding for R&D, which is about half of what our economy spends every year for R&D trains and supports engineers and scientists to perform research that, when done in an academic setting, ends up contributing to the body of human knowledge. The research is top quality which is evident by the large number of Nobel prizes we always manage to win.

But it almost seems as if while we are winning all the prizes, the rest of the world is reading our scientific journals, searching our patent files, and trying to come up with ideas that they can sell right back to us.

The SBIR Program caused a lot of controversy when it was first brought up, as you are well aware. I think the underlying reason behind all this controversy was because SBIR does not fit the established molds that have been established for research. It is not basic research. It is a kind of hybrid of basic and applied research.

People had a hard time conceiving of what it was we were trying to achieve with this bill. But that is exactly what we are trying to do with this bill, break the established molds. We are trying to get new people involved in federally funded research activity.

Basic research is vitally important to increasing the awareness of our changing world, and innovative research is important to the development of new products and processes to solve national problems and improve our quality of life.

The SBIR concept in no way attempts to favor basic over applied, but merely tries to get some small share of the R&D dollar to small, high-technology companies so they can demonstrate what they can do best and what our economy needs most—technology transfer.

I want to close by saying that the SBIR Program is exactly what our country needs to keep its place in the international economy. Sure, there are administrative problems, but when you give out $450 million in $50,000 chunks, there are going to be some glitches. Besides the new jobs that the program generates, it has helped us keep ahead of our international competition. In the area of fiber optic sensor technology, the Japanese are very, very serious competitors. The SBIR Program has given us the capital and it has given us the support to stay ahead of the Japanese. Hopefully, this program will also help us take this technology into the marketplace.

I can almost assure you that without this type of funding, we wouldn't be pursuing this angle, and we would probably lose this market to the international competitors.

So, I hope that we can work together, the small business community and Congress and the administration, for the next couple of years and see if we can take care of the little problems that hinder the program, but at the same time keep our focus on the big picture and keep America moving in the right direction.

[The prepared statement of Mr. Levine follows:]

Testimony

of

Mark J. Levine

on

The Small Business Innovation Research Program

before the

Senate Small Business Committee

March 3, 1986

GEO-CENTERS, INC.

Good morning. Thank you for the opportunity to testify before the Small Business Committee. I believe the Committee's interest in the progress of the Small Business Innovation Research program is both timely and well advised.

I am here representing my employer, GEO-CENTERS, INC. and its President and founder, Dr. Edward Marram. GEO-CENTERS, founded in 1973, is a member of Inc. Magazine's list of the fastest growing privately held companies in America. We employ 165 people and have offices in Boston, Albuquerque, Washington, D.C. and Dover, New Jersey. Our growth rate in revenues and employment have more than doubled in the past two years, and have increased ten-fold since 1980.

We have been a successful participant in the federal government's Small Business Innovation Research program. We have won several SBIR Phase I awards, and we have been awarded three Phase II contracts. Although our SBIR work is not our most significant source of revenue, we feel that program is of tremendous importance to our Company and other innovative small businesses.

Our Company is at a sensitive crossroad. We have demonstrated our technical and business management skills. We are now at the point where we must make hard decisions as to how best we can serve our employees, stockholders and the marketplace. Over our twelve years existence, we have developed and patented some very exciting and potentially lucrative innovations. Our participation in the SBIR program has been an important factor in our attempt to chart a new course for GEO-CENTERS.

Our Company has extensive experience in the field of fiber optic sensor technology. We have designed and built prototypes of sensors that far outperform conventional electro-mechanical

GEO CENTERS, INC.

sensors on both measurement sensitivity and cost. In addition to being able to replace conventional industrial sensors, our sensors are immune to electro-magnetic interference and can be safely used in corrosive, explosive, radioactive and other hazardous environments. This unique ability opens up several new uses for sensors that are extremely valuable in many areas of our society.

GEO-CENTERS currently has three Phase II SBIRs under way. We are optimistic about our opportunities to win at last two more Phase II awards in the spring. Each of these five SBIR awards stem from GEO-CENTERS' special abilities in fiber optic technology.

o We are developing a sensor system under Phase II of the SBIR program for the wing structures of military and commercial aircraft. This system will tell pilots, while in flight, whether there is too much stress on the aircraft's wings as well as informing mechanics of the exact location of fractures. This sensor has the potential to reduce a large part of the scheduled maintenance on military aircraft; as fighter planes are routinely broken down to physically search for possible fractures in their wings.

o We have also designed, under Phase II of the SBIR program, a system to deliver electric power to remote areas. Our experience with fiber optic materials has led us to develop a fiber pure enough to theoretically transmit laser light as far as 10,000 km. The Navy is interested in this program because it gives them a new and better way to power underwater, unmanned submarines. We feel there is a substantial need in commercial markets to deliver power to hard-to-reach places.

- We are one year into a Phase II effort to develop a soft munitions ignition system for the Army using fiber optic technology. This novel system, for use in large caliber conventional weapons, could lead to a completely recoilless artillery piece. Such a system would greatly reduce the wear and tear on the gun muzzle.

- We have just completed a very successful Phase I effort to develop an optical electric field sensor for the Air Force. The sensor is being developed as a device to measure the effect of lightning on the hulls of aircraft made of composite materials. However, manufacturers of power transformers have long been concerned about the effects high electric fields and power surges have on their equipment. Interest has been expressed by more than one power transformer manufacturer in the progress of our SBIR work in this area.

- We have also completed Phase I work on a fiber optic roll rate sensor for the Army. Roll rate sensors are critical components in the design of many modern projectile guidance systems. Existing guidance systems are very expensive and require significant power to ensure reliable operation. The roll rate sensor we have built under our Phase I contract has successfully demonstrated high sensitivity, minimum physical size, low power requirements and immunity to environmental effects, such as temperature and radiation. The market for these sensors within the Department of Defense alone is considerable. Already a major robotics company has supported our application for Phase II funding. We have approached the aerospace, automotive and process control industries with our Phase I results as well.

I mentioned earlier that GEO-CENTERS was at an important crossroad and that the SBIR program has been a big help to our Company. We feel we have excellent product ideas and would like to make the transition from a strictly research and development company to one that designs systems, manufactures and markets new products. This is a very expensive proposition. A company like ours has very little leverage in the financial world. Bank financing is inappropriate in our case. Venture capital is a one shot deal that could mean the end of our current system of private ownership and management. We also have too much loyalty to our employees to trust GEO-CENTERS' future to outside investors at this point in our history.

Instead, the SBIR program has provided us with the capital and credibility to make the transition on our own. We are able to show potential investors progress toward a commercial prototype and give them a good idea of what we can do with their capital. Already we have been able to use our participation in the SBIR program to interest three large companies in a potential joint venture with GEO-CENTERS. Through our negotiations, we feel that the possibility of a joint venture is in the best interest of our employees and our Company's future. The combination of our expertise and technology with our partner's manufacturing, marketing and financial capabilities are just what we believe to be necessary to bring a successful product to market.

I want to close by saying that the SBIR program is exactly what our country needs to keep up in the international economy. Besides the new jobs the program generates, it helps keep us ahead of our international competitors. The Japanese are also very interested in fiber optic sensor technology. The SBIR program has allowed GEO-CENTERS to stay ahead of the Japanese in this important area. Hopefully, the program will also help take this technology off the shelf and into the marketplace. I can almost assure you that without the SBIR program our Company would lose its edge to the Japanese.

GEO-CENTERS, INC.

Senator **Rudman**. Thank you very much.

I would just comment that one of the major problems that we face which this bill obviously can't address by itself is the whole question of technology transfer and going from the basic research and development to a product and then to the commercialization of that product. I have seen some figures recently as to the number of products made in Japan. Up until recently, they were based on American technology, and it is a rather stupendous figure.

I want to assure all the witnesses this morning that the testimony here before this hearing in New Hampshire will be given the widest of possible dissemination. It is certainly going to be read with interest by many who are going to consider, probably next year as we start to look at reauthorization of the bill.

There have been very good witnesses here this morning. You have given me just exactly what the committee wanted to hear, what is good about the program, where the problems are, how we can improve it, and I thank you all for joining us.

The subcommittee will now stand adjourned.

[Whereupon, the subcommittee recessed, to reconvene subject to the call of the Chair.]

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OVERSIGHT ON THE SMALL BUSINESS INNOVATION AND RESEARCH PROGRAM, PUBLIC LAW 97-219

TUESDAY, MARCH 11, 1986

U.S. Senate,
Subcommittee on Innovation and Technology,
Committee on Small Business,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:52 a.m., in room SR-428A, Hon. Warren Rudman (chairman of the subcommittee) presiding.

STATEMENT OF HON. JOHN F. KERRY, A U.S. SENATOR FROM THE STATE OF MASSACHUSETTS

Senator Kerry [acting chairman]. This hearing will come to order.

Senator Rudman apologizes for his inability to be here at the beginning of this hearing. As many of you know, he has played a central role; he was one of the key people in 1982 who was responsible for the passage of the SBIR Program, and he has been one of the principal sponsors of it since and has been watching it closely.

This oversight hearing on Public Law 97-219 is an effort by the Subcommittee on Innovation and Technology to take a hard look at this program, where it is today, and begin to make our assessments as we go into the reauthorization process next year about how we might be considering to improve the program and where we ought to go.

As most of you know, the Small Business Innovation and Development Act was designed to address some very real problems in this country, not the least of which is the significant loss by the United States of its world leadership position in the field of innovation and technology advancement; also a recognition of the need to stimulate job production capabilities for the private sector; and, finally, I guess, a need to ensure the greatest return possible for the Federal R&D investment at a time of mounting Federal deficits and some tough choices that we are making about where those dollars are going to go.

The competitive standing of this country in the international marketplace, needless to say, depends in a large degree on our ability to be able to maintain an edge in development of new technologies, and I think everyone who has anything to do with this committee is, needless to say, more than sensitized about the whole issue of small business' role in that effort.

I think that it is important to recognize that the SBIR Program was specifically designed for small high-technology firms with a strong R&D capacity. Over the last year or so, there are some questions that have arisen about phase 1 and phase 2 funding gaps, some issues about definitions, some questions about how we might be able to spread the wealth a little more evenly, and other kinds of issues that have arisen, all of which we are very interested in hearing about today.

Let me just comment that one signal of the success of this program is that, in 1983, participating Federal agencies working with the Small Business Administration received and responded to over 84,000 requests for solicitations and processed some 8,562 proposals, and many projects reviewed and recommended for funding far exceeded the funding that was available.

I am obviously very pleased with the Massachusetts response during the first 2 years of the program. Some might argue that we have gotten more than our fair share, though I obviously would not agree with them. [Laughter.]

But we are very pleased to be following second behind California in the absolute awards and first by per capita, notwithstanding that we are open to the argument, and need to listen to people who might argue, that the distribution process is something that needs to be reviewed.

So as we approach this hearing, we will listen carefully, with the understanding that we are trying to frame a better response, we want to make what we think is a good program better, and we would like to hear from those people who have been directly involved with it in helping to make it work, either by being recipients or administrators, as to what we can do in order to do that.

We have three panels, a fairly full menu this morning. For those of you who can, it is always helpful, given the fact that we have your full testimonies and we will submit those full testimonies to the record, but it is sometimes more helpful to get a dialog going, if you feel comfortable with the notion of summarizing and of giving us an overview of some of that written testimony; I think that sometimes helps us to have a more lively and engaging conversation.

Before we turn to the first panel, I would like to turn to my colleague, Senator Nickles, and ask if he has an opening comment he would like to make.

STATEMENT OF HON. DON NICKLES, A U.S. SENATOR FROM THE STATE OF OKLAHOMA

Senator NICKLES. Thank you, Senator Kerry, and I appreciate your interest as well as Senator Rudman's. I was on this committee when we originally authorized Small Business Innovative Research [SBIR].

I look forward to hearing statements from the panelists today. I apologize to at least our second panelists because I am going to have to scoot shortly. But we have had some interesting results in my State.

I am also pleased, on behalf of Senator Boren and myself, to present Dr. Ernest Koerner. Dr. Koerner did his graduate work at

Iowa State University and received his Ph.D. in chemical engineering in 1956. Since then, he has worked with a number of organizations such as Union Carbide Metals and also Monsanto.

In 1970, Dr. Koerner founded TECHRAD as a division of the Benham Group to provide research and laboratory analytical services for industrial and governmental clients. In 1983, he purchased TECHRAD from the Benham Group to become an independent small business consulting firm. He currently oversees all technical aspects of research and development projects conducted by the firm.

Dr. Koerner's extensive knowledge of chemical processes has led to much involvement with hazardous waste problems. He currently serves as a consultant to clients operating three waste sites and is frequently called upon for his recommendation in matters regarding treatment and disposal methods.

Dr. Koerner has participated actively in the air quality field by designing meteorological monitoring stations for power companies. His research efforts also have resulted in several patents. It is one example, I think, of success where SBIR has really proven an ability to reach out and help in lots of small endeavors in R&D. So I compliment Dr. Koerner and I look forward to his statement as well as those of our other panelists.

Senator KERRY. Thank you, Senator.

Without objection, I would like to enter into the record a statement by Senator Bumpers, who is unable to be here right now, in support of the program with his comments. If that statement could be placed at this point in the record, I would appreciate it.

[The prepared statement of Senator Bumpers follows:]

STATEMENT BY SENATOR DALE BUMPERS
OVERSIGHT HEARING ON P. L. 97-219
THE SMALL BUSINESS INNOVATION DEVELOPMENT ACT
SUBCOMMITTEE ON INNOVATION AND TECHNOLOGY
COMMITTEE ON SMALL BUSINESS
MARCH 11, 1986

MR. CHAIRMAN, THANK YOU FOR SCHEDULING THIS HEARING TODAY ON THE SMALL BUSINESS INNOVATION AND REASEARCH PROGRAM. THE SBIR PROGRAM IS NOW FOUR YEARS OLD. IN PREPARATION FOR THE REAUTHORIZATION OF THIS PROGRAM IN THE NEXT CONGRESS, THIS HEARING WILL EXAMINE ITS OPERATION AND TRY TO IDENTIFY ANY PROBLEMS WITHIN THE PROGRAM, AS WELL AS ITS ACCOMPLISHMENTS.

SMALL BUSINESSES ARE LEADERS IN INNOVATION AND JOB CREATION. STUDIES SHOW THAT SMALL FIRMS ARE MORE THAN TWICE AS INNOVATIVE PER EMPLOYEE AS LARGE BUSINESSES. THE SBIR PROGRAM RECOGNIZES THIS FACT AND IS PRECISELY THE TYPE OF PROGRAM NEEDED TO REVERSE THE DECLINE IN INNOVATION WHICH HINDERS AMERICAN PRODUCTIVITY AND LOWERS UNEMPLOYMENT.

THE PROGRAM'S OBJECTIVES ARE TWO-FOLD: TO ENCOURAGE THE GREATER INVOLVEMENT OF THE SMALLER TECHNOLOGICALLY BASED FIRMS IN THE RESEARCH AND DEVELOPMENT EFFORTS OF THE FEDERAL GOVERNMENT, AND TO TARGET THAT SUPPORT TOWARD DEVELOPMENT OF TECHNOLOGY WHICH WOULD FIND COMMERCIAL APPLICATION AND FUNDING IN THE PRIVATE SECTOR. THE FIRST GENERATION OF PROJECTS FUNDED BY THIS PROGRAM WILL BE COMPLETED THIS YEAR UNDER PHASE II. EXAMINING THESE PROJECTS SHOULD GIVE US A PREVIEW AS TO

WHAT PROPOSALS WILL BE FUNDED AND WHAT THE PROSPECTS ARE FOR PHASE III.

WHILE A DIVERSITY OF SMALL FIRMS ARE BEING BROUGHT INTO THIS PROGRAM, THERE APPEARS TO BE SOME SIGNIFICANT GEOGRAPHIC DISCREPANCIES IN THE AWARDING PROCESS THAT NEED TO BE EXAMINED. THE DISTRIBUTION OF AWARDS IS, AS EXPECTED, SKEWED TOWARD THE MORE POPULOUS STATES. MASSACHUSETTS AND CALIFORNIA COLLECTIVELY TOOK FORTY PERCENT OF ALL AWARDS WITH COMPARATIVELY MINIMAL REPRESENTATION OF SMALL FIRMS IN OTHER REGIONS OF THE COUNTRY. IN MY STATE THERE HAVE ONLY BEEN TWO PHASE I SBIR AWARDS, AND ONE OF THESE WAS NOT RENEWED. THIS WOULD INDICATE THAT MANY TECHNICALLY COMPETENT FIRMS, PARTICULARLY THOSE LOCATED IN THE RURAL STATES, WHICH ARE QUALIFIED TO PARTICIPATE IN THE PROGRAM ARE NOT DOING SO. BY CHOICE OR CIRCUMSTANCE THESE FIRMS ARE EFFECTIVELY CLOSED OUT OF THE PROCESS. EFFORTS BY THE SBA AND THE AGENCIES TO REACH INVENTORS AND INNOVATIVE BUSINESSES IN THESE OTHER STATES SHOULD BE CAREFULLY EXAMINED. WE ALSO NEED TO EXAMINE THE CRITERIA UNDER WHICH EACH AGENCY SOLICITS PROPOSALS TO DETERMINE IF THIS PROBLEM IS INHERENT IN THE PROGRAM OR MERELY A MATTER OF BETTER DISSEMINATION OF INFORMATION IN THE MORE POPULOUS STATES.

THE BENEFITS FROM THIS PROGRAM ARE MYRIAD. FOR SMALL BUSINESSES, THERE ARE GREATER OPPORTUNITIES FOR PARTICIPATION

WITH GOVERNMENT AGENCIES, EMPLOYMENT OPPORTUNITIES, INCREASED PROPECTS FOR COMMERCIAL TECHNOLOGICAL VENTURES, ENHANCED TECHNOLOGICAL TRANSFER OF RESEARCH INTO NEW SERVICES AND PROJECTS, AND INCREASED PROFITABILITY. FOR THE GOVERNMENT, THERE ARE BROADER TECHNOLOGICAL CONTRIBUTIONS FROM THE PRIVATE SECTOR, EXPOSURE TO INNOVATIVE SMALL BUSINESSES, AND A COST-EFFECTIVE MEANS OF ACHIEVING TECHNOLOGY DEVELOPMENT.

IT IS CLEAR THAT SMALL BUSINESS IS PLAYING AN INCREASING ROLE IN THE FIELD OF HIGH TECHNOLOGY WITH ITS PARTICIPATION IN SBIR. I LOOK FORWARD TO HEARING TODAY'S TESTIMONY AND TO WORKING WITH THE COMMITTEE TO EXPAND THIS IMPORTANT PROGRAM.

Senator Kerry. The other three panelists are Dr. Herbert Platt, the president of Genetic Diagnostics Corp. from Great Neck, NY; and I am personally delighted to welcome a husband and wife team from Massachusetts, Dr. David Franklin and Loretta Clement Franklin from Audiological Engineering, Inc., which is based in Somerville, MA which has been doing some fascinating work in the area of tactile hearing aids, and we are delighted to have you here, and I am personally delighted to welcome what we consider the cutting edge of technology in Massachusetts, and we are delighted to have you.

So why don't we lead off with you, Dr. Platt, if you want to start off, and we will run right through here.

Dr. Platt. It will be my pleasure.

Senator Kerry. Thank you.

Since nobody from New York is here to speak for you, we are going to let you go first. [Laughter.]

Dr. Platt. I will write that down in my little book, and I will keep that.

STATEMENT OF DR. HERBERT A. PLATT, PRESIDENT, GENETIC DIAGNOSTICS CORP., GREAT NECK, NY

Dr. Platt. I am very pleased to have the opportunity to speak with you here today regarding the work that has been accomplished at Genetic Diagnostics, particularly as a direct result of your essential Small Business Innovative Research Awards.

Genetic Diagnostics is a publicly owned corporation in Great Neck, NY, and we specialize in one of the newest areas of scientific endeavor, biotechnology. Within this very broad category of research, our scientific staff is producing high quality antibodies which can be used to detect and counteract toxins, disease organisms, and other foreign materials which we term antigens.

The method is called monoclonal antibody production and is unique in that it enables us to produce these materials in a test tube, from cells known as hybridomas.

These antibodies, in addition to their use as immunizing agents, have proven to be extremely useful in the diagnosis of disease by immunoassay test. These antibodies have particularly great value because they are specific, sensitive, and because of this, they will speed reaction time, eliminate the need for radioactive substances, and actually lower the costs of testing.

Because of their superior properties, we went a step further and developed and patented two very practical diagnostic methodologies which utilize monoclonal antibodies. One is a self-timed immunoassay device, a convenient, disposable, hand-held unit which enables one merely to insert a test sample into its top chamber and then learn whether the sample is positive or negative by simply reading the indicator on the side of the device.

The other diagnostic methodology, an instrument, also portable, provides the user with an exact measurement of the substance being tested. At present, only highly trained individuals are capable of performing such tests. With these systems, anyone in this room will find it easy to perform an immunoassay test on a given sample.

Both the device and the instrument are expected to have great applicability in physicians' offices, hospitals, laboratories, veterinary clinics, rural locations, and in other specialized operations.

Since our founding in 1981, we have been involved in performing research on the university level as well as for the U.S. Government and several major corporations. In addition, in November, we were one of the first companies in the country to enter into joint venture discussions with the People's Republic of China to organize a separate company in China for the production of monoclonal antibodies and various diagnostic kits.

During the last 2 years, we have been fortunate enough to receive a number of SBIR phase I grants for portions of at least three major projects. I would interrupt my text at this time and say that last year we were also indeed fortunate to be the recipient of the largest number of awards in New York State, so that we can compete with Massachusetts effectively. [Laughter.]

Senator KERRY. We will have to change that. [Laughter.]

Dr. PLATT. I am sorry I said that.

These three major projects include one for our work in detecting food contaminants known as mycotoxins, another for research in detecting the specific cause of infectious diarrhea in humans and animals, and a third for the development of a testing system which will detect and measure levels of marijuana in humans.

As to the first, there are a number of toxin-producing fungi which grow in cereals, grains, and other foodstuffs and which cause serious illness and deaths in humans and animals. There has been great difficulty in studying the natural occurrence of mycotoxins because a rapid and sensitive diagnostic assay has not been available.

With the help of SBIR phase I and phase II awards in the amounts of $50,000 and $180,000, respectively, we have made significant progress toward the goal of producing such diagnostic assays.

In the first phase of our project, we developed 36 monoclonal antibodies for testing mycotoxins. In our phase II investigations, we are selecting the most appropriate of these antibodies for prototype testing. We will then develop a monitoring device which will greatly decrease the accidental exposure of humans and animals to these toxins which are existent in certain foodstuffs. The next phase, under commercial auspices, will be to protect the prototypes and to extend the methodology for real world use.

Infectious diarrhea, another major problem, is a severe medical problem in less developed countries where it kills thousands of children each year, and it is a leading killer of newborn animals such as calves and pigs in the United States.

A phase I award for approximately $50,000 has been a great help in our development of monoclonal antibodies to the E. coli bacteria, a significant cause of the diarrhea in humans, and to coli bacillosis, a significant cause of diarrhea in farm animals.

A phase II application has already been prepared and filed. We believe that our approach is directly on target for achieving a stable, long-term solution to the problem of diagnosing and treating infectious diarrhea. Our initial findings are promising enough to expand the program to include other bacteria and viruses.

We at Genetic Diagnostic have also been applying our skills to the preparation of a number of monoclonal antibodies to THC metabolites, the active ingredient in marijuana. Although a number of analytical tests are currently available for the detection and measurement of marijuana levels in the human body, all of these require highly trained personnel and the use of sophisticated instrumentation.

Particularly because of the problem of false positives, there has been a specifically large need for an immunoassay test device which is capable of easily and rapidly measuring cannabinoid compounds, the active ingredients of marijuana, particularly in urine, blood, saliva, and for use in research as well as in specific instances of military work and law enforcement, sports events—one can go on with this.

Our preliminary research in SBIR phase I study of approximately $50,000 clearly demonstrated the feasibility of creating antibodies for use in the detection and measurement of marijuana. Our phase II study has already been awarded and presently awaits funding, which should be in the next week or two. This will provide significant support for furthering our goal in this phase of developing a system which can easily and rapidly measure marijuana levels in humans.

At the conclusion of our proposal study, we hope to have fully operational prototypes which will then be ready for final development into useful and commercially viable products in the aforementioned areas.

If I had another hour or two, I could certainly go on about these and other exciting areas of research and development in which we are involved, such as the detection and identification of infectious diseases in various parts of the world. We have an involvement with the Defense Department in this particular area.

I would also report positively on progress, also under our phase I awards, in which certain molecules play a critical role in tumor processes as well as in the characterization of Alzheimer's disease. But I will restrain myself from this and close by addressing the question as to how the awards have helped further the goals of our company and offer my thoughts on how their implementation could be improved.

Without these awards, there is no question that the important research I have just described would have been seriously hampered. The money goes toward supplementing every imaginable aspect of the project, from basic supplies to the salaries by which we retain skilled and dedicated scientists.

In regard to suggestions on program implementation and inquiries as to the interest of small firms in participating in this program, let me address the last part of that first. Yes, there is certainly an interest on the part of small innovative firms for involvement in the SBIR Program, and this has been evidenced by the increase in the last 3 or 4 years in the number of applicants for these project awards.

The only comment I can offer regarding a suggestion is that I hope you will consider the expansion of the program to include more awards for innovative small businesses around the country. I believe that you will find the little guy, so to speak, if properly screened, can respond the fastest to ever-changing research needs, thereby making the SBIR Program one of the most economically feasible ways for research to flourish in our country.

Thank you once again for your interest and your support. We believe the results we continue to achieve will fully justify the faith you have placed in us in the work we are doing to create a safer and healthier world.

Thank you.

[The prepared statement of Dr. Platt follows:]

Genetic Diagnostics Corporation GDC 160 Community Drive, Great Neck, New York 11021

March 11, 1986

Remarks before the Senate Subcommittee on Innovation and Technology by Dr. Herbert A. Platt, President Genetic Diagnostics Corporation

I'm very pleased to have the opportunity to speak with you here today regarding the work that has been accomplished at Genetic Diagnostics Corporation as a direct result of your essential Small Business Innovative Research Awards.

Genetic Diagnostics is a publicly owned company in Great Neck, New York. We specialize in one of the newest areas of scientific endeavor, biotechnology. Within this broad category of research, our scientific staff is producing high quality antibodies which can be used to detect and counteract toxins, disease organisms and other antigens. The method is called monoclonal antibody production, and is unique in that it enables us to produce antibodies in a test tube, so to speak, from cells known as hybridomas.

These antibodies, in addition to their use as immunizing agents, have proven to be extremely useful in the diagnosis of disease by immunoassay test. These antibodies speed reaction time, eliminate the need for radioactive substances, and lower the costs of testing.

Because of their superior properties, we went a step further and developed and patented two very practical diagnostic methodologies which utilize monoclonal antibodies.

One, a Self-Timed Immunoassay Device, is a convenient, disposable hand-held unit which enables one to merely insert a test sample into its top chamber, then learn whether the sample is positive or negative by simply reading the indicator on the side of the device.

The other diagnostic methodology, an instrument, also portable, provides the user with an exact measurement of the substance being tested. At present, only highly trained individuals are capable of performing such tests. With these systems anyone in this room would find it easy to perform an immunoassay test on a given sample. Both the device and the instrument are expected to have great applicability in physicians offices, hospitals, laboratories, veterinary clinics, rural locations and in other specialized operations.

Since our founding in 1981, we have been involved in performing research on the university level as well as for the United States government, and for several major corporations.

In addition, in November we were one of the first companies in the country to enter into joint venture discussions with the People's Republic of China to organize a separate company in

China for the production of monoclonal antibodies and various diagnostic kits.

During the last two years, we have been fortunate enough to receive SBIR Phase I grants for portions of at least three major projects: one for our work in detecting food contaminants known as mycotoxins, another for research in detecting the specific caused of infectious diarrhea in humans and animals, and a third for the development of a testing system which will detect and measure levels of marijuana in humans.

There are a number of types of toxin-producing fungi which can grow in cereals, grains and other foodstuffs, and which cause serious illness and deaths in humans and animals. There has been great difficulty in studying the natural occurrence of mycotoxins because a rapid and sensitive diagnostic assay has not been available. With the help of an SBIR Phase I and Phase II Award in the amounts of $50,000 and $180,000, respectively, we have made significant progress towards the goal of producing such diagnostic assays. In the first phase of our project, we developed 36 monoclonal antibodies for testing mycotoxins. In our Phase II investigation, we are selecting the most appropriate of these antibodies for prototype testing. We will then develop a monitoring device which will greatly decrease the accidental exposure of humans and animals to these toxins which are existant in certain food stuff. The next phase under commercial auspicies, will be to perfect the prototypes and extend the methodology for "real world" use.

Infectious diarrhea is a severe medical problem in less-developed countries where it kills thousands of children each year, and it is a leading killer of newborn animals such as calves and pigs in the United States. A Phase I Award for approximately $50,000 has been a great help in our development of monoclonal antibodies to E. coli bacteria, a significant cause of diarrhea in humans and to coli bacillosis, a significant cause of diarrhea in farm animals. A Phase II Application is under preparation. We believe our approach is directly on target for achieving a stable, long-term solution for the problem of diagnosing and treating infectious diarrhea. Our initial findings are promising enough to expand the program to include other bacteria and viruses.

We at Genetic Diagnostics have also been applying our skills to the preparation of a number of monoclonal antibodies to THC metabolites, the active ingredient in marijuana. Although a number of analytical tests are currently available for the detection and measurement of marijuana levels in the human body, all of these require highly-trained personnel and the use of sophisticated instrumentation. There has been a large need for an immunoassay test device which is capable of easily and rapidly measuring cannabinoid compounds, the active ingredients of marijuana, in human urine, blood and saliva for use in research as well as for application in law enforcement and military work.

Our preliminary research in SBIR Phase I study of approximately $50,000 clearly demonstrated the feasibility of creating antibodies for use in the detection and the measurement of marijuana. Our Phase II study has been awarded and awaits funding. This will provide significant support for furthering our goal in this phase of developing a system which can easily and rapidly measure marijuana levels in humans. At the conclusion of our proposal study, we hope to have fully operational prototypes which will then be readied for final development into useful and commercially viable products in the aforementioned areas.

If I had another hour or two, I could certainly go on about these and other exciting areas of research and development in which we are involved, such as the detection and identification of infectious diseases in various parts of the world. I would also report positively on progress, also under our Phase I Awards, in which certain molecules play a critical role in tumor processes as well as in Alzheimer's disease. But I will restrain myself, and close by addressing the question as to how the Awards have helped further the goals of our company, and offer my thoughts on how their implementation could be improved.

Without these awards, there is no question that the important research I have just described would have been seriously hampered. The money goes towards supplementing every imaginable aspect of the project, from basic supplies to the salaries by which we retain skilled and dedicated scientists.

In regard to suggestions on program implementation, and inquiries as to the interest of small firms in participating in this program, let me address the last part of that first. Yes, there certainly is an interest on the part of small innovative firms for involvement in the SBIR Program. This is evidenced by the increase during the last three or four years in the number of applicants for these project awards.

The only comment I can offer regarding a suggestion, is that I hope you will consider the expansion of the program to include more awards for innovative small businesses around the country. I believe that you will find "the little guy," so to speak, if properly screened, can respond the fastest to ever changing research needs thereby making the SBIR Program one of the most economically feasible ways for research to flourish in our country.

Thank you once again for your interest and your support. We believe the results we continue to achieve will fully justify the faith you have placed in us in the work we are doing to create a safer, healthier world.

AVAILABLE

Senator KERRY. Thank you, Dr. Platt.

I think what we would like to do is run right through the entire panel and then we will go into questions.

So, Dr. Koerner, if you would go ahead, we would appreciate it. Thank you, and I welcome you, also.

Dr. KOERNER. Thank you, sir.

Senator KERRY. Thank you.

STATEMENT OF DR. ERNEST L. KOERNER, P.E., PRESIDENT, TECHRAD INC., OKLAHOMA CITY, OK

Dr. KOERNER. Good morning, ladies and gentlemen. We appreciate the opportunity to present our views on our experience on the SBIR Program to this committee.

Since Senator Nickles so kindly introduced me, I guess I can speed that part of it up.

TECHRAD was founded in 1970 as Technology Research and Development. We were at that time a member of The Benham Group, a national architect-engineering firm headquartered in Oklahoma City. Our charter then was to provide environmental, chemical engineering, analytical laboratory, and research and development activities to industrial and municipal and government clients.

As the environmental emphasis shifted from assessments and impact statements to toxic and hazardous wastes, The Benham Group opted not to pursue this avenue because of potential future liabilities with the toxic waste problem. So, in August of 1983, they offered the firm for sale and we purchased it at that time and formed a new corporation under the name TECHRAD, a small business corporation. Thus, although we are only 3 years old as TECHRAD today, we are really 17 years old. We are starting our 17th year of business come June 1, providing R&D and consulting services to industry.

We presently employ 24 engineers, environmental scientists, chemists, and technicians organized into an engineering group, an environmental group, and an analytical laboratory.

Our SBIR award program is entitled "Pilot Plan Investigation of Coal-Wood-Limestone Pellets as an Industrial Fuel Source." We were funded by the Department of Energy. Our first phase grant was for $49,926 and our second phase grant is for $494,596.

Briefly, what we are doing is producing coal-wood-limestone pellets for use as an industrial fuel, utilizing waste coal fines from secondary coal operations. The key to our project is that we have developed a potentially inexpensive binder to form the pellet. We make this from hydrolyzed wood in which we convert the cellulose to sugars, and with the lignin, it then forms a very good binder for the coal.

The addition in our case, like in Oklahoma, of adding more waste wood, mixing more waste wood—sawdust, if you will—with the coal, high-sulfur coals, especially, we can reduce the sulfur content in the coal and thereby make it marketable. One of the problems that we face in Oklahoma is that we have a large amount of high-sulfur coal which is just not marketable for power plant utilization. We have also found that by adding limestone to the pellet, we were able to trap the sulfur in the ash, thereby allowing it to be burned in a powerplant.

Our phase II program is to demonstrate the production of the hydrolyzed cellulose for binder and the pelleting of the coal-wood-limestone pellets. We are going to be doing it in a pilot plant to obtain pilot plant scale-up data and economic data, and the program is to be carried out in a 10-ton-per-day pilot plant. So you can see we are not on a lab scale any more.

The size of the pilot plant was partially dictated by the requirements to produce substantial quantities of pellets for test marketing, and as an example, one of the large potential users is in cement manufacture, but they require about 200 tons as a minimum for a test burn.

There are several commercial potential benefits for this project. The most important benefit to be derived from this effort is that it would utilize coal and wood wastes as an industrial fuel. Coal fines and sawdust are now largely wasted natural resources because of lack of technology to put them into a marketable form. The available large tonnages of these wastes provide private enterprise with profitmaking opportunities and, at the same time, allow certain industries to stabilize their energy bills with lower cost fuel.

The utilization of coal fines derived from secondary recovery operations also offers the potential to conserve an equivalent amount of virgin coal. In addition, by furnishing a cheaper fuel source than oil and gas, these natural resources are also reserved for future use. It is especially important at this time to replace as much oil usage as possible to reduce the Nation's dependence on imported oil.

The potential benefit for the successful commercialization of this process can also be measured in many millions of dollars of profits for the secondary coal operators. There is also an equal amount of wages and benefits to workers plus the normal multiplier that employed persons contribute to an area's economy, plus lower energy costs for the fuel users. These benefits are far greater than the estimated $494,000 cost to perform the phase II study.

I was asked to comment on the benefits of the program to TECHRAD's mission. The original goal when the firm was established in 1970 was to provide research and development expertise to the growing industrial base in Oklahoma. This goal was only partially accomplished over the years as the firm became more involved with the environmental movement.

Since our separation from the Benham Group, TECHRAD has reestablished the goal of becoming predominantly a research and development company. The SBIR Program has been a great benefit to us in our quest to meet this present goal.

What is the potential for commercialization? Recently we have signed a letter of intent with Stake Technology Ltd. in Ontario, Canada, to form a joint company to market the coal pelleting technology. Stake Technology has a patented process to hydrolyze cellulose using only high pressure and temperature. The hydrolyzed cellulose is used for animal feed and as the starting raw material for recovery of other chemicals such as glucose, xylose, and ethanol. Stake Technology's principal business is marketing this technology.

Our patented process to accomplish the same conversion is done by using acid conditions and lower temperature and pressure. However, we learned that Stake Technology has a production plant in Minnesota capable of producing almost 100 tons a day of binder, so with this, we have decided to join forces. With their existing production capabilities and our expertise in coal pelleting, we thought that the combination of the two firms' talent should lead to quicker commercialization.

In addition, Stake Technology has a worldwide marketing organization which would greatly assist market development. I might comment here that we have had inquiries from literally all over the world on pelleting coal. The utilization of coal fines is a tremendous problem.

We have a few suggestions for improvement in the SBIR Program. TECHRAD, as a small business, is excited about the possibilities and opportunities that the SBIR Program offers to small firms. Our own experience with the operation of the Department of Energy's program has all been positive.

One suggestion for improvement that we would make would be a more liberal method of funding the phase II work. Whereas the phase I program is funded in advance, the phase II program payments are made 30 to 45 days after the work is performed and upon submission of a proper invoice. For small firms like ourselves, we have to borrow the money from our friendly banker to accomplish the project.

Also, after reviewing many of the projects chosen for SBIR grants, we suggest that additional attention be given to projects such as ours. These are practical applications of common, everyday problems that need to be solved. This is not to take away from the high tech types of activities that Dr. Platt just described, but we think there is room for both of them in the program.

We have some further suggestions for improving the SBIR Program: We would like to see the SBIR Program made permanent. We would like to see the program expanded from 1.25 percent to 2.5 percent or even 4 percent.

We would like to expand the Federal agency participation to all Federal agencies with extramural budgets of $20 million rather than $100 million.

We would also like to see a requirement of the Governmentwide application of the Department of Energy's improved treatment of the successive funding of phase I and phase II proposals to eliminate the delay between the programs. As you are aware, the DOE Program can go into an accelerated phase II, which helps immensely that you do not have this large gap waiting between the two of them.

As a small business firm, TECHRAD strongly believes that the real technical breakthroughs and advances come from our sector. The SBIR Program is an excellent vehicle to continue these advances.

We thank you for the opportunity to speak to this committee.

[The prepared statement of Dr. Koerner follows:]

TECHRAD

Consulting Engineers | Analytical Laboratory

STATEMENT OF
Dr. Ernest L. Koerner, P.E., President
TECHRAD Inc.
4619 N. Santa Fe
Oklahoma City, OK 73118-7995
405/528-7016

TO
United States Senate
Committee on Small Business
Subcommittee on Innovation and Technology
Russell Senate Office Building
Room 428A
Washington, D.C. 20510

March 11, 1986

This statement is concerned with our experience with The Small Business Innovative Research (SBIR) Program funded by P.L. 97-219. We are here at the invitation of Senator Lowell Weicker, Jr., Chairman, Committee on Small Business, and Senator Warren B. Rudman, Chairman of the Subcommittee on Innovation and Technology. We appreciate the opportunity to present our experience with our Phase I and Phase II SBIR grants. Our thanks are expressed to the Senators and the Committee Members for listening to our story.

4619 North Santa Fe Oklahoma City, Oklahoma 73118 405-528-7016

EXPERIENCE WITH THE SMALL BUSINESS INNOVATIVE RESEARCH PROGRAM

TECHRAD - AN OVERVIEW AND BRIEF HISTORY

TECHRAD Inc. was formerly Technology Research & Development, Inc. (TECHRAD), founded in 1970 by Dr. Ernest L. Koerner, P.E., as the environmental, research and and development member of The Benham Group, Inc. (TBG), a national architectural/engineering/planning firm.

While a member of TBG, TECHRAD provided environmental, chemical engineering, analytical laboratory, and research and development services to industrial, municipal and government clients.

As the environmental emphasis shifted from assessments and impact statements to toxic and hazardous wastes, TBG opted not to expose the company to the potential future liabilities of toxic and hazardous wastes projects. The firm was offered for sale to Dr. Koerner and in August, 1983, the purchase was completed and a new small business corporation was established under the name of TECHRAD Inc. Thus, although our present corporation is less than three years old, TECHRAD will be starting its 17th year in business on June 1st.

TECHRAD presently employs 24 engineers, environmental scientists, chemists, and laboratory technicians organized into an Engineering Services Group, Environmental Services Group and an Analytical Laboratory.

TECHRAD's Engineering Group offers civil, chemical and mechanical engineering services for water supply and treatment systems; industrial and municipal wastewater systems; and liquid and solid waste recycling and disposal systems. Services include the design and operation of complete water and atmospheric monitoring systems for industrial plant sites; pilot plant studies for the development of water and wastewater treatment processes; process and detailed engineering design of water and wastewater treatment systems; and investigation, analysis and design of hazardous waste treatment processes.

The Environmental Services Group provides capabilities in a wide variety of disciplines including aquatic and terrestrial ecology, water quality, engineering, cultural resources (archeological, historical, and social), and meteorology; it has the management expertise to properly develop and implement a plan of study. Specific strengths include complete familiarization with federal and state environmental regulations, design of monitoring networks and programs, knowledge of permit requirements, excellent research facilities and capabilities, and highly qualified technical writing capabilities.

TECHRAD maintains a modern, well-equipped chemical laboratory staffed with experienced, competent chemists and technicians to provide analytical chemistry services and environmental testing. Wet chemical analysis, instrumental analysis, and biological services are available.

TECHRAD offers comprehensive industrial hygiene services to industry and government agencies under the management of a board-certified industrial hygienist. Field crews are available to sample and evaluate asbestos, chemical vapors, dusts, fumes or mists, as well as noise intensities, ionizing and non-ionizing radiation, and heat stress to determine if compliance with OSHA standards exists.

TECHRAD'S SBIR AWARD PROGRAM

Title: Pilot Plant Investigation of Coal-Wood-Limestone Pellets as an Industrial Fuel Source

DOE Phase I **Award:** $ 49,926.00
DOE Phase II **Award:** $494,596.00

Brief Description of Process:

The Phase I program demonstrated the potential technical and economic feasibility of producing coal-wood-limestone pellets for use as an industrial fuel source. Waste coal fines from secondary coal recovery operations can be used in the pellets. A potentially inexpensive material made from hydrolyzed wood waste was used as the binder to form the pellets. The addition of waste wood to certain high sulfur coal fines has the advantage of lowering the sulfur content in the fuel pellet to make it more marketable. By also adding limestone to the pellet, it was demonstrated that SO_2 emissions were greatly reduced by trapping 80-95 percent of the sulfur in the ash. A synergistic sulfur removal effect was found from the limestone and the alkali in the wood ash.

The Phase II program is to demonstrate the production of hydrolyzed cellulose for binder and the pelleting of coal-wood-limestone pellets in a pilot plant to obtain plant scale-up and economic data. The program is to be carried out in a ten ton per day pellet pilot plant.

The Phase II program is to be run in three parts. The hydrolysis of cellulose to produce the binder will be studied first. Next, the pelleting operation will be studied. It is intended to compare the technical and economic advantages of pelleting versus briquetting. In the third part, quantities of pellets will be produced for market testing by potential users.

The size of the pilot plant is partially dictated by the requirement to produce substantial quantities of pellets for market evaluation. For example, the minimum quantity of coal pellets required for a cement plant demonstration is 200 tons.

Potential Commercial Benefits:

The Phase I study demonstrated the technical and potential economic feasibility of producing coal-wood-limestone pellets for use as an industrial fuel source. A potentially inexpensive material made from hydrolyzed waste wood was used as the binder to form the pellets. The Phase II program is designed to determine the manufacturing cost for the hydrolyzed wood binder by demonstration in a pilot plant operation.

There are several important benefits that can be derived from the successful application of the proposed technology. The most important benefit to be derived from this effort is that it would utilize coal and wood wastes as an industrial fuel. Coal fines and sawdust are now largely wasted natural resources because of technology to put them into a marketable form. The available large tonnages of these wastes provide private enterprise with profit-making opportunities and, at the same time, allow certain industries to stabilize their energy bills with lower-cost fuel.

The utilization of coal fines derived from secondary recovery operation offers the potential to conserve an equivalent amount of virgin coal for future generations. In addition, by furnishing a cheaper fuel source than oil and gas, these natural resources are also reserved for future use. It is especially important at this time to replace as much oil usage as possible to reduce the Nation's dependence on imported oil.

Coal producing areas traditionally have been economically deprived areas. Any technological improvements that will increase coal production or recovery from secondary sources will benefit the economic climate of these regions. They will provide job opportunities for the unemployed of these areas. Oklahoma is no different from other coal producing areas in this respect. Oklahoma contains vast coal reserves estimated at over 7.7 billion tons. However, 66 percent is classified as being undesirable for burning by utilities and industries because of high sulfur emissions. Any technology that increases the marketability of these coals is a benefit to the state.

In the same coal areas of Oklahoma, there are numerous saw mills which produce large quantities of sawdust and other wood wastes. Most of this large, renewable wood waste resource is not used in any by-product recovery operation. The proposed process utilizes this wasted resource to produce an acceptable binder for the coal pellets and, in addition, is used as a fuel source where the market demands allow. Thus, a wasted, natural, renewable resource is put to economic use.

In their present condition, waste coal piles and ponds are eyesores, blights to the surrounding community, a degradation to surrounding land values, a deterrent to land productivity, and pose continuing environmental problems. With the proposed technology helping to establish markets for the coal recovered from secondary coal operations, economic incentive will exist for mine operators to recover this coal. These efforts will provide the means for reclaiming the land, providing job opportunities, providing a more refined product which should lead to further market opportunities, and ultimately to eliminating the environmental problems.

Successful operation of the pilot plant to confirm the estimated production costs or coal-wood-limestone pellets would create new opportunities to market high sulfur coal and coal fines from secondary coal recovery operations. The immediate potential commercial application is for a coal pellet for the cement industry. This market can utilize pelleted coal fines with up to 2.5% sulfur. Some cement plants burn 40-70 tons of coal per hour. A secondary market exists for a coal-wood-limestone pellet for industries.

Coal operators have reported a cost of 4 to 8 dollars per ton of recovered coal to process secondary coal through a wash plant. Digging, transportation and royalty costs add another 4 to 8 dollars per ton. Adding a conservative 6 dollars per ton for the pelleting operation results in a production cost of around 14-22 dollars per ton. One Oklahoma operator reported selling coal pellets for 30 dollars per ton recently. Under these conditions the gross profit would be 8-16 dollars per ton. Mining virgin coal by strip mining in Oklahoma is presently costing between 16-22 dollars per ton.

The potential benefit for the successful commercialization of this process can be measured in many millions of dollars of profits for the secondary coal operators, an equal amount in wages and benefits to workers plus the normal multiplier that employed persons contribute to an area's economy plus lower energy costs for the fuel users. These benefits are far greater than the estimated $494,596 cost to perform the Phase II study.

BENEFITS OF SBIR PROGRAM TO TECHRAD'S MISSION

The original goal when the firm was established in 1970 was to provide research and development expertise to the growing industrial base in Oklahoma. This goal was only partially accomplished over the years as the firm became more involved with the environmental movement. Since our separation from TBG, TECHRAD has re-established the goal of becoming predominantly a research and development company.

Besides the present SBIR program, TECHRAD has prepared two other SBIR applications for clients. In both cases TECHRAD would perform much of the research and development at its facilities.

The SBIR program has been a great benefit to TECHRAD in our quest to meet our present goals.

[illegible] AVAILABLE

PHASE III FUNDING

TECHRAD has signed a letter of intent with STAKE TECHNOLOGY LIMITED Oakville, Ontario, Canada, to form a joint company to market the coal pelleting technology. STAKE TECHNOLOGY has a patented process to hydrolyze cellulose using only high pressure and temperature. The hydrolyzed cellulose is used for animal feed and as the starting raw material for recovery of other chemicals such as glucose, xylose and ethanol. STAKE TECHNOLOGY's principal business is marketing this technology.

TECHRAD's patented process to accomplish the same conversion utilizes acid conditions and lower temperatures and pressures. However, STAKE TECHNOLOGY has a production plant in Minnesota capable of producing almost 100 tons/day of hydrolyzed cellulose binder.

With STAKE TECHNOLOGY's existing production capabilities and TECHRAD's expertise in coal pelleting, combining the two firm's talents should lead to quicker commercialization. In addition, STAKE TECHNOLOGY has a worldwide marketing organization which will greatly assist market development.

SUGGESTIONS FOR IMPROVEMENT OF THE SBIR PROGRAM

TECHRAD as a small business firm is excited about the possibilities and opportunities that the SBIR program offers to small firms. Our own experience with the operation of the DOE program has all been positive. One suggestion for improvement would be a more liberal method of funding the Phase II work. Whereas the Phase I program is funded in advance, Phase II payments are made 30-45 days after the work is performed upon submission of a proper invoice. For small firms like ourselves, we have to borrow the money from our friendly banker to accomplish the project.

After reviewing many of the projects chosen for SBIR grants, we suggest that additional attention be given to projects such as ours. These practical applications are not extremely "high tech", but offer broad-based benefits to regional economics and the consumer.

Further suggestions for improving the SBIR program include:

- Make the SBIR Program permanent.
- Expand the small business set-aside from 1.25% to 2.5% or even 4.0%.
- Expand the Federal Agency participation to all agencies with extramural budgets above $20 million instead of the present $100 million.
- Require government-wide application of the Department of Energy's improved treatment of the successive funding of

Phase I and II proposals to eliminate unwarranted delay in receipt of funds.

As a small business firm, TECHRAD strongly believes that the real technical breakthroughs and advances come from our sector. The SBIR program is an excellent vehicle to continue these advances.

Thank you for the opportunity to speak to this Distinguished Committee.

ERNEST L. KOERNER, Ph.D., P.E.
President, TECHRAD Inc.

Dr. Koerner founded TECHRAD as a division of The Benham Group in 1970 to provide research, development and laboratory analytical services to industrial, municipal and governmental clients. In August 1983, he purchased TECHRAD from The Benham Group to become an independent, small business consulting firm. He is the principal reviewer for all technical aspects of research and development projects conducted by the firm.

He has served as consultant to Monsanto Company, Union Carbide Metals Company, Hanna Mining Company, U.S. Steel AgriChem, Olin Corporation, DEMCO, Inc., J.R. Simplot Company, Ingersoll-Rand Company, Oklahoma Publishing Company, and the Bartlesville Energy Technology Center. He has participated in the design and preparation of specifications for demineralizers, regeneration systems, acid and caustic handling systems for the Anheuser-Busch can plant, St. Louis, for three stream electric stations for Mississippi Power & Light, for research and development laboratories for Conoco and Halliburton Services, and for several industrial plating plants. Dr. Koerner has developed an advanced wastewater treatment process for industrial and municipal wastewaters and acts as a consultant to municipalities and industries relating to wastewater treatment. He possesses considerable expertise in wastewater treatment processes, has managed two studies to determine wastewater treatment needs at six steam electric stations to bring the plants into compliance with the 1977 water discharge regulations, directed an industrial wastewater survey for Oklahoma City, Oklahoma, and has been Technical Director for projects involving development of a new process for teritiary treatment of wastewater, Envitrol Process for treating wastewater from meatpacking and rendering plants, upgrading municipal wastewater treatment plants, design of package wastewater plant for offshore oil production platforms, and a new sludge disposal process. He was Technical Director for an EPA project to assess the long-term effects of applying wastewater to the land. This project involved a one-year study at four sites, Roswell, N.M., Dickinson, N.D., Milton, WI., and Vineland, N.J. and included the drilling of wells, the collection and analysis of over 30,000 water, soil and vegetation samples, and the preparation of four comprehensive reports.

His extensive knowledge of chemical processes has led to TECHRAD's involvement with hazardous waste problems under the Resource Conservation and Recovery Act (RCRA). He presently serves as a consultant to clients operating three waste sites and is frequently called upon by industrial clients to recommend either treatment or disposal methods.

In the air quality field he has participated in the design and preparation of specifications for three meteorological and air quality monitoring stations for three power companies, served as Project Director for a one-year operation and maintenance project for the Sooner Meteorological and Air Quality Monitoring Station and for three years for data processing and report preparation for the Sooner Meteorological and Air Quality Reports. He has also participated in the preparation of the environmental assessment reports for Oklahoma Gas and Electric Company's 1100-MW coal-fired Sooner Generating Station and for the 490-MW coal-fired Grand River Dam Authority's plant.

Dr. Koerner has demonstrated considerable accomplishments in solvent extraction and ion exchange technology. A major accomplishment was the development of a solvent extraction process to purify wet process phosphoric acid to produce detergent phosphate salts. Process resulted in seven patents and was patented in 27 foreign countries by Monsanto. Ten million pounds per year STP plant was built and operated at Augusta, Georgia. He also developed and patented a process for recovery of vanadium from ferrophosphorus. Plant was built and operated at Soda Springs, Idaho, by Kerr-McGee Corporation. Raw material is ferrophosphorus from Monsanto's phosphorus plant. He has also served as Technical Director for DOE projects to demonstrate engineering feasibility of the new BERC process to recover waste oils by solvent extraction.

His research efforts resulted in patents being granted on new methods to produce refractory metal carbides directly from ores, a process to recover high purity calcium metal from calcium carbide, two processes to separate and recover high purity rare earth metals gadolinium, samarium, europium, lanthanum, and cerium, a process to separate niobium and tantalum, a high temperature rotary kiln and a mixer-settler extractor without interstage pumps. The process for converting metal oxides to carbides led to the development of Union Carbide's vanadium carbide - CARVAN. Plant was built in South Africa utilizing the oxide conversion process and the high temperature rotary kiln to produce vandium carbide. The mixer-settler development was utilized by Union Carbide in the niobium- tantalum production unit. This equipment replaced columns and was scaled up three different times without any changes. In addition he holds patents on a process to separate niobium and tantalum by solvent extraction, a process for recovery of uranium which involved an alternate leaching technique that reduced chemical consumption, and a process to recover vanadium from wet process phosphoric acid.

EXPERIENCE

1983 to date	TECHRAD Inc.: President
1970 to 1983	TECHRAD, research and development division of The Benham Group, Inc., President
1967 to 1970	Kerr-McGee Corporation: Senior Research Group Leader
1959 to 1967	Monsanto Company: Research Specialist, Inorganic Research Division
1957 to 1959	Union Carbide Metals Company: Research Section Leader

EDUCATION

Bachelor of Chemical Engineering, 1953, University of Dayton
M.S., Chemical Engineering, 1955, Iowa State University
Ph.D., Chemical Engineering, 1956, Iowa State University

REGISTRATION

Registered Professional Engineer: Oklahoma

Senator **Kerry**. Thank you very much, Dr. Koerner. We appreciate it.

Dr. Franklin and Mrs. Franklin.

STATEMENT OF DR. DAVID FRANKLIN, PRESIDENT, AUDIOLOGICAL ENGINEERING, CORP., ACCOMPANIED BY LORETTA CLEMENT FRANKLIN, SECRETARY/TREASURER, AUDIOLOGICAL ENGINEERING, CORP., SOMERVILLE, MA

Dr. **Franklin**. The subject of our grant—we had a phase I and are nearing the end of the phase II now—is wearable tactile aids, which are devices that essentially allow a deaf person to feel sound.

We brought along the unit. This is our present unit. It is a small box of electronics with a microphone and, in this particular case, a single vibrator which a deaf person would wear against his skin. This particular vibrator was developed by SBIR funds.

A basic problem in this area—the area is actually quite old; people have been doing research on it at the university level for about 50 years—a major, major problem, probably the largest problem in the field, has been the absence of a decent skin vibrator. I would say the largest thing that the SBIR funding has allowed us to do is to in fact make a vibrator available.

The history of our company is as follows: My wife and I started the company in July 1982 for the purpose of developing and marketing tactile aids. Because everybody felt that the market was too small, and in fact that there was no evidence that this kind of device really helped, we were unable to raise any significant amount of money. I might add that that situation really pretty much still exists.

There were several people from MIT and Children's Hospital in Boston who felt that the work we were doing was worthwhile, and so they helped us with some amount of capital and a great deal of help in other ways, and we started to design an aid that was based in part on some work that was done at MIT and later on at Johns Hopkins University and essentially designed this device somewhat before the start of the SBIR Program.

We started selling the device in April 1983, and early in 1983 we became aware of the SBIR Program. We applied for a phase I grant, received it, started work on this skin vibrator in October, and showed that in fact it did look feasible to build something like this.

In September 1984 we received our present phase II grant, which will end in August of this year. The amount of this grant is $500,000 including overhead, and the subject is in three parts.

The first part was to develop this vibrator, and that is completed, and it is actually in production now and being sold.

The second part was to develop an advanced processing device that was much smaller than this one and used somewhat more advanced processing technologies. That is pretty much done now. The design is complete, and we are currently packaging it.

The third part was to place a reasonably large number of these aids out into institutional situations so that they could be evaluated. We have selected, I guess now it is about 40 institutes across the country, one in England and several in Australia, who will be receiving these devices approximately in June. Additionally, we have a very large controlled study which has already started at the Lexington School in New York.

Now, I think one of the very important things about this field is that it is very small. I think that wanting to help the deaf is something like motherhood, but it is a peculiar situation in that, although there are a fairly large number of deaf in the world, from a commercial point of view, it is very difficult to see how venture capital would be willing to address itself to this kind of market.

For example, we estimate that the potential number of sales per year is somewhere around 10,000 at the present level of the device, which is pretty good but not in any sense a substitute for hearing; I mean, it is not an artificial ear. We think it may become that if we continue getting support, and at that level perhaps there would be 30,000 potential sales per year worldwide, which is still not really a very large number.

This particular device costs about $600 a unit, so it represents about $6 million a year in potential market size, and it would be very difficult to get the kinds of funds that are necessary for the kind of research that has to be done in order to develop this sort of device from venture capital. So, from that point of view, SBIR is pretty much it. We have been unable to find any other sources for this kind of development.

It is sensible to ask whether or not these devices are any good because that certainly is a criterion as to whether or not you want to spend the kind of funding that SBIR is putting into us, half a million dollars the first time around.

At the present time—I should say that in 1982 when we started, essentially there were no wearable tactile aids, so there was no issue of going around and looking for people wearing these things; there weren't any.

In 1986 now—and I am talking worldwide—there are about 1,000 deaf individuals wearing these devices. There are six companies in business making them. I think from what I have said previously it is pretty clear that not all six companies are going to survive, but there has been a reawakening of interest in the field that is extremely dramatic.

There are two companies that pretty much lead the field. Both of them are American companies. I am happy to say we are one of them. The other one is a company in California, and interestingly enough, that company also received a phase II SBIR grant.

I should state that it is not a duplication of effort because the two approaches that these companies are using are very, very different. We are using a mechanical vibration approach; the other company is using an electrical stimulation approach. It will be rather interesting in the end to see which one is the more successful.

Australia and New Zealand have become convinced enough at this point of the value of even this simple a device so that they have both undertaken systematic programs to fit all the profoundly deaf school-age children in their countries with tactile aids. In both cases they have selected our aid.

It is expected that other countries with similar medical device deployment systems probably will do something similar. In the

United States, third-party payments have become routine. There are only 1,000 units out there now, but they are certainly more than doubling each year; there is no question. In effect, the sales have really only started to happen less than a year ago, I would say, and it is 1,000 now, and I am certain that, a year from now, it will be well over 2,000, probably more likely 3,000 or 4,000.

Most schools for the deaf in the United States are now aware of these devices and are beginning to very routinely purchase them, and many clinics for the deaf are, as a routine matter, both prescribing the aids and giving training for them. This is another very exciting thing to see because, when these aids first came out, nobody was quite sure how to use them, and people do seem to be able now to find ways to very specifically train for them.

We had not expected to see very many profoundly deaf adults using these aids. Much to our surprise, within the last 6 months, that in fact appears to be a trend.

I think the point is that without the SBIR Program, none of this would have happened. There is just absolutely no way. There would have been no funding. I think that we probably would have existed, but we certainly would not have had the capability to go ahead and develop this kind of vibrator and the next device which is coming out, which is about a third the size of this. It has two channels instead of one.

We would not have had the resources to release our income from sales of these devices to put it into advertising and other sorts of things which have enabled us, in the last year or so, to make a considerable impact in the marketplace, which is evidenced by the six companies out there now, not all in the United States, though. Two are in the United States, I guess, and the other four are from other countries.

I think this is all due to SBIR; I don't think there is any question about it at all. So our feelings about SBIR should be very clear, because this is a field that is extremely important to us.

Finally, I have three suggestions about the SBIR Program. One of them, I suspect, will be very argumentative.

First of all, I think the SBIR Program should give some very real consideration to setting up regional support facilities, which some people call incubators. I think there are a couple of States that are now doing things like this, and it may be that the SBIR should not do it directly, but maybe the SBIR Program should encourage this. Maybe they should even allow some of the SBIR grant funds to be used for this purpose.

The reason that I think it is so important is because there are a lot of little startup companies like us. We have basically six full-time employees and two part-time employees. We are not entrepreneurs. Our primary background is technological, and it was a big shock to all of us to get into the business arena and see just how difficult it is for groups with our lack of business background to be able to function in that arena.

I think there are a lot of ideas like ours that are basically not—they are not money losers, but they are not money makers; they are not going to be able to attract venture capital. I think that for those kinds of companies and those kinds of orphan devices, these incubators would be very, very useful in increasing the output, the efficiency of the funds spent through SBIR. If part of the reason of the SBIR is to cover some of these orphan products, then I think this would probably be one of the best ways of doing it.

I also think—and this is the one that I think is argumentative—there are some situations where it is reasonable for very small companies developing orphan devices to use phase II funds for marketing and advertising. I know that that sounds as though I am suggesting something that comes close to being illegal, but I really think the realities require getting the world to know about their products, as it was in the case of our device, so that becomes a very legitimate way to use funds for development.

And, finally, the item that I am sure everybody has trouble with, is the timelag between phase I and phase II. I hear from Dr. Platt that New York State in fact gives funds to bridge between phase I and phase II, which is very nice. Unfortunately, Massachusetts does not, and what happens is that you tend to lose key personnel, particularly if you are a small company. You have no way to hold onto these people because you are waiting for 6 months or more, and they go away. That has not happened to us—we have been extremely fortunate—but I know of a number of other cases where it has.

That is all I have to say. Thank you.

[The prepared statement of Dr. Franklin follows:]

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COMMENTS TO THE SUBCOMMITTEE ON INNOVATION AND TECHNOLOGY REGARDING THE SBIR PROGRAM MARCH 4,1986

These comments are from Audiological Engineering Corp., a Massachusetts Company, that has received an SBIR Phase II Grant from the National Institutes of Health (NINCDS) to investigate and develop wearable tactile aids for the deaf. The Program Manager at NINCDS for this project is Dr. Earleen Elkins. The comments and related testimony were invited by Warren B. Rudman in his capacity as Chairman of the Subcommittee on Innovation and Technology which is to hold an oversight hearing on the SBIR Program, P.L.97-219, on March 11, 1986.

Gentlemen and Ladies:

I will be discussing wearable tactile aids. These are sensory substitution systems that use tiny vibrators mounted against the skin and driven by a microphone and appropriate processing electronics. The idea is to enable a profoundly deaf person to "feel sounds".

My wife, Loretta, and I founded Audiological Engineering in July, 1982, with the purpose of developing and selling wearable tactile aids for the deaf. The funds for starting the company were very limited and provided by ourselves and a group of professionals from MIT and Childrens Hospital Boston. The company used space available in our private dwelling and still continues to operate out of the same location.

Prior to starting Audiological Engineering I had attempted, unsuccessfully, to interest a number of commercial and research groups in developing some simple wearable tactile aids and to establish field studies of them. The collective position was that a) they probably wouldn't work; and b) even if they did, no significant market existed. From this, it is reasonable to place tactile aids for the deaf in the catagory of "orphan devices"; that is, desireable items that either are not commercially attractive or only marginally so.

These opinions are perhaps understandable in that, although research on tactile aids has gone on for over 50 years, no effective devices have ever appeared on the market; and although the total number of profoundly deaf in the United States alone is in excess of 300,000 individuals, they tend to be a group with less than average economic resources, and hence are not viewed as an attractive market for investment; an unfortunate situation.

Clearly, from our action, my wife and I did not agree with the first objection and thought the second was remedial.

Using the funds raised, less than $10,000 dollars, and working part time, we were able to develop and package a wearable aid based in part on work done at MIT and Johns Hopkins University. We placed 10 aids at The Lexington School for the Deaf in New York and several aids at the University of Iowa. By April, 1983 we had enough confidence in the device to begin selling it. All initial sales were by word of mouth since we did no advertising until February, 1984, at which time I published an article in a hearing aid trade journal and placed a small ad in the same publication.

Early in 1983 we became aware of the SBIR Program, and in April, 1983, we applied for a Phase I grant. The subject of our application was to investigate the possibilities of developing a good skin vibrator for use in wearable aids. The absence of such a device was (and had been so recognized for many years) the most serious lack in technology which had prevented the field from advancing. Indeed, The Committee of Hearing, Bioacoustics and Biomedical Devices (CHABA) of the National Research Council had concluded that unless such a device became available, effective tactile aids would never be developed.

In October, 1983, we received our requested grant, and by March, 1984 had concluded that there were several approaches that in fact looked very promising. Based on our final report we were awarded a Phase II Grant for $500,000,including overhead, which commenced in September, 1984 and will end in August, 1986. The thrust of this grant was somewhat expanded from the original intent to include the following items:

1) Development of an effective skin vibrator for use with wearable tactile aids.

2) Development of a compact cosmetically acceptable wearable aid with improved processing.

3) Deployment of enough of these aids (about 200) to suitable clinical sites so that scientifically controlled studies could be carried out in statistically significant numbers thus verifying that, indeed, even simple aids really help. This last item includes funds for an ongoing study at The Lexington School in New York, where our first aids were sent.

At present (March, 1986), we have completed development of the new skin vibrator, started production of it, and have replaced the heavy inefficient vibrator used in our present tactile aid (called Tactaid I), with the new vibrator.

We have completed design of the new electronics and are in the latter stages of packaging. The new unit is about 1/3 the size of Tactaid I, incorporates advanced processing as well as many new features which our experience has taught us are desireable. This new device will be called Tactaid II.

The study at Lexington School has started (using Tactaid I); new training manuals have been written; a group of additional study sites have been selected, and Tactaid II units are scheduled to be delivered to them in June of this year.

We intend to start manufacturing and selling the new aid, Tactaid II, when we have established its effectiveness. The marketing and distribution of the new aid may be done either by our company or by one or more larger companies in the hearing aid business. At present, discussions are beginning with one such organization.

As a means of discussing the role of SBIR in our company and in the tactile aid field in general, I would like to review the present state of the tactile aid commercial situation as contrasted with what it was in 1982, when we started our venture.

In 1982 there were no commercial operations producing and selling tactile aids of any description except for a stationary teaching device called the" Fonator", manufactured and sold by Siemens of Germany.

In contrast, in 1986, there are six companies world wide manufacturing wearable tactile aids. All of these companies began manufacturing and distributing aids after Audiological Engineering demonstrated that, in fact, they worked.

Two companies with what are generally acknowledged to be the best aids, each of a different type, are United States Companies. Both have received Phase II SBIR grants which have been vital for bringing the aids to their present level of development. For the record, these two American companies are: Audiological Engineering Corp. of Somerville,Ma.; and Tacticon Corp. of San Rafael, California.

In 1982 essentially no deaf person had a wearable tactile aid for the simple reason that none existed. Curiously enough, and generally unknown to the research community, there were a smattering of teachers of the deaf who knew from their own experiences that the tactile modality, even crudely done, was useful. They occasionally outfitted young children with body type hearing aids and what are called "bone receivers" which can be used as a primative kind of skin vibrator.

As of 1986, at least 1000 profoundly deaf children and adults have been fitted with tactile aids of some description (about 1/2 of these are Tactaid I devices). Australia and New Zealand have undertaken systematic programs of fitting all profoundly deaf school children with tactile aids and it is expected that other countries will follow suit within the next several years.

In the United States third party payments are becoming increasingly more common, many schools for the deaf are ordering units for classroom use, and many clinics are prescribing wearable aids and providing training as standard treatments.

If, as I believe, this resurgence of interest in the tactile modality is due to the limited but definite success of the wearable tactile aids now offered on the commercial market, then the SBIR Program can claim credit without reservation.

It has been estimated that the total world market for simple wearable tactile aids is on the order of 10,000 units a year; if the aids become more effective as hoped, it is believed that the market may become as many as 30,000 units per year. The reasons for these relatively small market expectations are complex, but in part have to do with the competing technology of cochlear implants which are far more expensive than tactile aids, and in the end may not prove to be as good sensory substitution devices as tactile aids,but are generally conceded to be the treatment of choice for postlingually deaf adults who make up the vast majority of the profoundly deaf population.

Because of this relatively small market potential, it is highly unlikely that sufficient research and development funds could have been found without the SBIR Program. Without the continued support of the SBIR Program it is equally doubtful that the tactile technology will be able to attain its full potential.

In my mind it is very important to address the trend of today's society towards invasive treatment of human ills. The treatment of profound deafness by non-invasive tactile methods is an attractive and inexpensive alternative to cochlear implants which are both invasive and expensive.

One of the most rewarding aspects of this work has been feedback from teachers and parents of profoundly deaf children. They have consistently reported significant improvements in previously unresponsive children as to speech quality and frequency, responses to environmental sounds and an awakening of interest in lip reading, signing and social interaction.

Formal studies with two children, Megan (from 29 months to 44 months), and Tabitha (from 33 months to 43 months) have shown remarkable results. The older child, (Tabitha, now 12 years old), is mainstreamed, completely successful academically, and a social leader among her hearing peers. This is a very unusual outcome for a profoundly deaf child.

The other child, Megan, now 5, is showing language acquisition rates, both receptive and expressive, that fully match those demonstrated by Tabitha. Megan was the subject of a nationally shown TV Special on PBS (New Tech Times). We are very gratified.

Finally, in commenting on ways in which the SBIR Program could be improved I have three suggestions:

First, many start-up companies who are applying for SBIR Grants have little or no experience in operating businesses. They typically have no appreciation of the difficulties inherent in managing and coordinating a grant, in finding and dealing with potential Phase III support companies and, if necessary, as it often is, manufacturing and marketing their own product at least for a while. As a result of this, one would suppose that a fair number of worthwhile projects never come to fruition.

To alleviate this problem I would suggest that the SBIR Program give consideration to forming regional support facilities, sometimes called "incubators". Their mission would be to provide management and marketing expertise and limited manufacturing capability. Since many overhead and manufacturing functions could be combined for a number of small companies, the cost to the SBIR program would probably be very small and offset by increased efficiency of SBIR dollars spent. As I envision such structures, it would be included in their mission to help these companies to eventually locate other resources or combine with other companies in the incubator into viable self supporting units.

Second, I think that there are some situations involving orphan developments where use of Phase II money for marketing or advertising purposes would be sensible and appropriate. Hence, I further suggest that the constraints on Phase II funds be changed to include use for these purposes under certain circumstances.

Third, the time lag between Phase I and Phase II can be devastating to projects because of the loss of key personnel. To alleviate this it would be highly desireable to make every effort to minimize time between grant phases.

Thank you,

David Franklin
David Franklin, President

Loretta C Franklin
Loretta Clement Franklin, Secretary-Treasurer

AUDIOLOGICAL ENGINEERING CORPORATION
Somerville, Massachusetts.

tactaid®* I

tactaid I
AUDIOLOGICAL ENGINEERING CORPORATION

A WEARABLE VIBROTACTILE AID FOR THE PROFOUNDLY DEAF ADULT OR CHILD

This device enables the profoundly hearing impaired to feel sounds. It is more than just another high-powered hearing aid.

- All high frequencies lowered so all voice sounds can be felt.
- Patented circuits allow it to be used in noisy areas, even by children.
- Responds to voice and other meaningful sounds–does not respond to annoying background noise.
- Helps both the prelingually deaf child and the postlingually deaf adult.
- Battery operated; completely self contained.
- Compatible with FM transmission systems.

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9 Preston Road, Somerville, MA 02143
617 - 623-5562 V/TDD

* Tactaid is a registered trademark of Audiological Engineering Corp.

WHAT IS THE TACTAID I?

The Tactaid I is a wearable device, similar in appearance to a body-type hearing aid, that lets a profoundly-deaf individual feel sounds. Processing includes frequency lowering so even the high pitch elements of speech can be felt. The vibration is sent to the skin, not the ear. It has been shown to be of significant help for lipreading, for sensing environmental sounds (footsteps, doorbells, traffic noise) and can be used both by young children and adults.

Teachers and clinicians have found the Tactaid helpful in teaching correct vocalization, voice control and speech rhythm. Prelingual children are observed to show more responsive behavior to both speech and environmental sounds and to maintain greater levels of spontaneous babbling, an important precursor to speech.

A very important feature of the Tactaid I is that it incorporates a patented automatic background noise suppressor circuit which allows it to be used in noisy areas. Furthermore, this result is obtained without the user adjusting any external controls.

The Tactaid I is simple to use. The vibrator is worn either on the chest or the wrist, and the electronics package with its built-in microphone is clipped to a pocket or belt. Because of the patented noise-suppressor circuit, Tactaid I has only a single control which seldom need be used. This is particularly important with children, but also of great convenience for adults.

For both children and adults, the ability to sense environmental sounds such as fire alarms, traffic sounds, doorbells, telephones and footsteps promotes safety, confidence and more relaxed social functioning.

To accommodate use in special classrooms for hearing-impaired children, the Tactaid I is compatible with FM transmission systems of the Ear Mark type.

For more information, contact your otolaryngologist, audiologist, or dealer, or write to Audiological Engineering Corporation.

SPECIFICATIONS FOR TACTAID I

Electronics case with belt clip	2.5"x4.5"x1.5", 200 gms
Vibrator	B72-1.25"x1.12"x0.7", 47 gms B70-1.25"x0.6"x0.7", 16 gms
Power supply	4 AA rechargeable cells. Operating time-20 hours between charges, charging time-12 hours
Power supply drain	4 ma quiescent, 125 mils maximum output (specified at 4.8 volts)

System comes complete with plug-in charger and body harness (or wristband, as shown). Full one-year warranty.

V1220 VIBRATOR

AUDIOLOGICAL ENGINEERING CORPORATION IS PROUD TO ANNOUNCE THE FIRST VIBRATOR IN ITS NEW V1000 SERIES.

THE FEATURES OF THIS SERIES ARE:

- SMALLER AND LIGHTER
- EASIER TO WEAR
- NO BULKY HARNESS
- REDUCED POWER CONSUMPTION

UP TO NOW THE TACTAID I HAS BEEN SUPPLIED WITH A COMMERCIALLY AVAILABLE TRANSDUCER THAT WAS THE BEST AVAILABLE. AFTER OVER A YEAR OF DEVELOPMENT WE ARE NOW PRODUCING OUR OWN TRANSDUCER: THE V1220. LESS THAN HALF THE SIZE AND 1/6 THE WEIGHT OF THE PREVIOUS VIBRATOR, IT PRODUCES A SUPERIOR TACTILE RESPONSE.

THE POWER CONSUMPTION HAS BEEN GREATLY REDUCED, SO THE TACTAID CAN BE USED FOR A LONGER TIME BETWEEN BATTERY CHARGINGS.

THE V1220 TRANSDUCER CAN BE COMFORTABLY WORN ON THE CHEST OR WRIST. BECAUSE OF ITS REDUCED HEIGHT AND WEIGHT, IT IS COMPLETELY INVISIBLE WHEN WORN ON THE STERNUM UNDER A SHIRT OR BLOUSE.

THE V1220 TRANSDUCER IS NOW SUPPLIED WITH EVERY NEW TACTAID.

WEARABLE TACTILE AIDS

An Alternative to Cochlear Implants

BY DAVID FRANKLIN

Within the last two years a new class of assertive listening device has become commercially available. This device, called a "wearable Tactile aid," is a viable alternative to the cochlear implant for many profoundly deaf individuals, and has several advantages over a cochlear implant. The tactile aid is far less expensive, can be used on a trial basis, and has none of the risks associated with having an operation.

Unlike the cochlear implant, which attempts to stimulate the damaged hearing system with electrical signals, the vibrotactile aid addresses the tactile (feeling) sensors in the skin with a compact vibrator, similar in concept to a tiny loudspeaker. Thus, while the cochlear implant gives rise to sensations of "hearing", a vibrotactile aid gives rise to sensations of "feeling". While both techniques are limited compared to normal hearing, the amounts of information provided are significant and useful. At present levels of development, the two techniques are about equal in utility.

What kind of help can a profoundly-deaf individual expect to get from a tactile aid? The experience with the units currently in use (over 300) suggests quite a bit. First, one can expect to be placed in contact with the world of sound, to be aware of essentially all the sounds a normally-hearing person senses (footsteps, doorbells, telephones ringing, voices, baby crying, traffic sounds, etc.). Furthermore, with practice, one can expect to learn to distinguish among many of these sounds in a beneficial way, by virtue of the different rhythms and 'feelings' generated on the skin. Many of the users find the tactile aid of significant help in speech reading, as a safety device for being aware of traffic and other warning sounds, and generally as a help in feeling more "connected".

The opinions of parents and teachers regarding use of tactile aids on very young children (some as young as 6 months) have included comments on improved language acquisition rates, lengthened attention spans, and lowered frustration (not only for the subject children, but for their parents and teachers as well).

HOW THEY WORK

One wearable tactile aid, the Tactaid I, is shown in the accompanying photograph. The electronics case, which contains a microphone, is worn in any convenient location such as in a pocket or clipped to the belt. The vibrator can be worn either on the wrist or on the chest (a wrist harness is shown). In our experience, most adults wear it on the wrist, while most children wear it on the chest.

The Tactaid I is composed of the electronics case, which can be carried in pocket or clipped to belt, and the vibrator, worn with wrist harness (shown) or on the chest.

So, except for the vibrator, a tactile aid looks and is used much like a traditional body aid. In fact, if one were to take a very high powered body type hearing aid, replace the ear receiver with an appropriate vibrator, and use it in the same manner as a tactile aid, to some limited extent, a similar perception would be obtained. However, several important differences would be observed.

1. The strength of the vibration felt with the hearing aid would be very weak compared to that of the tactile aid. Also, the "richness" of the patterns felt would be much less, as a result, it would be much more difficult to differentiate among various sound sources with the hearing aid than it would be with the tactile aid.

2. With the hearing aid it would not be possible to feel any sound sources that generate only high frequencies. This is because the skin cannot feel frequencies much above 600 Hz. These unfelt sounds would include many important environmental sounds (doorbells, telephone bells, baby cries, many fire alarms, water running, kettle whistles), and most unvoiced speech sounds such as *s* and *t* in *sit* or *p* in *paper*. Tactile aids, on the otherhand, include special processing that lowers the frequency of the higher-pitched sounds so they can be felt.

3. With the hearing aid, the normal background sounds in a room would

cause the vibrator to run more or less continuously, making the output both annoying and useless. With a well-designed tactile aid, however, special circuitry, either manual or automatic, is incorporated to eliminate the unwanted background sounds.

In summary, one can say that tactile aids are more than simply high-powered hearing aids driving skins vibrators, and that their utility for many profoundly-deaf individuals, whether adult or child, has been found to be significant. Their performance is roughly equivalent to cochlear implants, they are much cheaper than implants, and, unlike implants, they can be tried out before purchase.

HOW TO TRY ONE

Similar to hearing aids, tactile aids are "restricted devices", that is, one needs a recommendation from a hearing clinic or other hearing health care professional to obtain one. The usual procedure is for the professional agency to order a unit on your behalf for a thirty day free trial. Note that the trial period and/or other terms may vary depending on the manufacturer contacted. Either you or your professional can contact the manufacturer directly to obtain descriptive material on their device and, additionally, your professional can request papers and other materials describing the use of these aids in various studies, as well as application tutorials.

CURRENT MANUFACTURERS

At present, there are three manufacturers offering tactile aids.

AB SPECIAL INSTRUMENTS
Box 27066, 102 51 Stockholm, Sweden
Tel. (08) 616600
Instrument name: MINIVIB3

AUDIOLOGICAL ENGINEERING CORP.
9 Preston Rd., Somerville, MA 02143
Tel. (617) 623-5562
Instrument name: TACTAID I

SIEMENS HEARING INSTRUMENTS, INC.
685 Liberty Ave., Union, NJ 07083
Tel. (201) 688-5150
Instrument name: MINIFONATOR

Profoundly deaf children can learn oral language quicker with the aid of a vibrator that helps them feel sound.

FEELING THE WAY TO SPEECH

BY LINDA ABRAHAMS

Learning to understand spoken language is a difficult task for children who are born deaf or lose their hearing before they can speak. These deaf children have no concept of speech or sound. Adele Proctor, assistant professor of speech-language pathology at Northeastern University, is helping such children learn to lipread with a special vibrotactile device.

In the next phase of her research, she hopes to teach these deaf children how to speak.

Proctor's research has shown that children can learn to lipread faster through the use of a vibrotactile device. This device transforms the rhythm, stress, and duration of speech into vibrations which the children can feel.

Standardized tests have shown that children have increased their oral language comprehension through lipreading when wearing the vibrotactile device.

Proctor first became involved with research on the vibrotactile device when she was a graduate student at the Johns Hopkins University in Baltimore. She was hired to field test and measure the effectiveness of a device that had been developed by an engineer.

The subject of that study was a 33-month-old girl named Tabitha. Before wearing the device, Tabitha inconsistently understood five words through lipreading and produced limited vocalization. She could not be given formal speech and language tests because of her inability to lipread and comprehend the directions for taking a test. After 10 months of training with the device, she had acquired an understanding of 469 words.

During the study, Tabitha's mother, teacher, and speech-language pathologist independently kept track of the single words that she comprehended through lipreading. "A word was recorded if the child responded appropriately at least three times and demonstrated through action, gesture, or vocalization that she understood. For a word to be counted as a permanent part of the child's vocabulary, consensus was required from two of the three observers," Proctor said.

Tabitha acquired understanding of the first 10

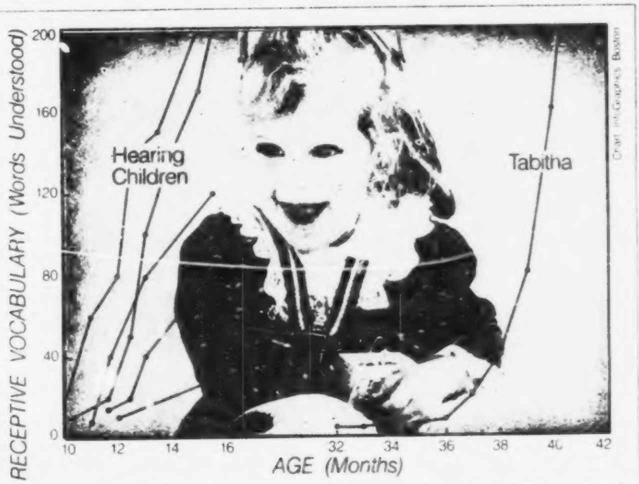

Chart: Info Graphics Boston

Graph shows that once profoundly deaf children begin acquiring language, they make progress similar to that of hearing children

words at the age of 37 months, much later than the 10 months it takes hearing children. Tabitha understood 50 words about one and a half months after she understood her first 10 words; hearing children understood 50 words an average of three months after they understood 10 words. She understood 100 words at the age of 39 months (two months after she understood her first 10 words); six of eight hearing children studied comprehended 100 words at the age of 14 months (four months after they understood their first 10 words).

"These data show that after the deaf child understood the first 10 words through lipreading, her rate and pattern of acquisition was similar to hearing subjects," Proctor said.

The data also showed that hearing children understood a higher proportion of action words than did Tabitha, while Tabitha understood a slightly higher percentage of personal-social words such as "hi" and "bye-bye."

"We proved the device was good for learning oral language among the profoundly deaf children (those with very little residual hearing)," Proctor said

A conventional hearing aid often can be beneficial in helping a child with some residual hearing to perceive and produce speech. Traditional hearing aids also can be used in conjunction with the vibrotactile aid, which does not rely on any residual hearing and provides information about features of speech that cannot be obtained through amplification alone.

Unlike traditional hearing aids, the vibrotactile device blocks out most background noise and picks up only the speech of people talking to the child or the speech of the child. When the device is used with conventional hearing aids, it can help a child get maximum results from the hearing aids.

When Proctor first used the device, it was sewn into a vest that could be worn by the child. Since then, the design has been modified so that it can be slipped over a child's clothing and held in place with elastic straps

The vibrator and microphone are worn against the child's breast bone close to the vocal cords to enable the child to make the connection between the production of sound and the vibration of the device.

When Proctor starts working with a child, she applies the vibrator to different parts of the body to get the child used to this different type of stimulation. Once the child gives an indication of being able to accept it—for example, the child can hold it in his or her hand—she puts the device on the child so he or she feels the vibration at the sternum.

"Some portion of the therapy is direct. I point to pictures of family members or objects around the house and name them," Proctor said.

When she names something and the child makes any kind of sound in response, she gives the child some kind of "social reinforcement," such as a pat on the head or clapping her hands.

Nine months of age is usually when deaf children stop babbling. "It is important to get them vocalizing again and to establish some communication with their parents," Proctor said.

Proctor must get her subjects to look at her when she names objects and must get them used to looking at her when she speaks. She then holds their hands on the vibrator. "It seems to take about five weeks for the child to realize that what she feels is a result of what I am doing. A profoundly deaf child has no concept of speech or sound," she said. However, "it takes five to six months for the children to get a sense that they can make the vibrotactile device work and that they can make sound. Without the device, it

Adele Proctor works with Kristina (also pictured on preceding two pages). The vibrotactile device has helped Kristina become alert to sound.

takes as long as three years to get a deaf child to understand that she can make sound."

Proctor has been working with two-year-old Kristina since she was nine months old. "Kristina consistently vocalizes and has produced words like bye-bye and ma-ma. She seems to understand body parts, clothes, and common household objects," Proctor said. She also can sense when sound is present. In a recent test, Kristina responded to sound at a normal conversational level while wearing her hearing aids. "It is unusual to obtain results of this nature from a 27-month-old. This means that the vibrotactile device has helped Kristina to be alert to sound and to develop a concept that when other people speak, she is expected to react in some way," Proctor said. "The tactile aid enables Kristina to make maximum use of her hearing aids."

Proctor describes using a vibrotactile aid as a multi-sensory approach incorporating vision, touch, and movement to compensate for the lack of hearing.

Before she starts working with a child, she gives a hearing test and gathers medical information to determine that the child is normal except for a lack of hearing. She also makes videotapes of the child alone and with his or her mother to use as a basis of comparison.

"Part of the problem is that there are no measurement techniques to determine how effective the devices are. We gauge our success from our experience, from the child's progress in learning language, and from what we see clinically," she said. "There is just general information available now about how children develop when they have this kind of hearing loss. There is no real data on how they acquire oral language."

The device also helps the children's voice quality. "Kristina's voice quality is considered appropriate for a child of her age, meaning that the tactile device has helped her monitor her voice so she does not sound like a typical profoundly deaf child. When she does vocalize, it is pleasant to listen to her," Proctor said.

Through the use of the device, the children "can modify what goes on with their vocal cords. It gives them a mechanism to check what they are saying," Proctor said. For example, when Proctor says 'ma-ma,' a child can feel the two distinct beats. When the child imitates that speech, he or she can feel whether two distinct beats are being produced.

Now, Proctor is working to make Kristina able to distinguish between one-syllable and two-syllable words and to be able to tell when sound starts and stops. "I'll work on specific articulation after she can distinguish syllables. I'll try to transfer the knowledge of the beats to specific speech."

Proctor is now working with five profoundly deaf children through the aid of a $10,000 grant from the Deafness Research Foundation. She also has received a $2,500 grant from Northeastern's Biomedical Research Support Grant fund and $5,000 from Northeastern's Research and Scholarship Development fund for this work.

Proctor recently was awarded a second $10,000 grant from the Deafness Research Foundation. That grant will enable her to purchase five additional vibrotactile devices. She is training speech-language pathology students at Northeastern to use the device with profoundly deaf children.

Also through the new grant, she will study speech of the children to try to find ways to make the device more effective for learning speech. She plans to tape record them before she starts the training, and then tape them after she has worked with them to determine whether or not using the device has improved their speech.

Senator **Kerry**. Thank you all very, very much.

I think that, for all of us, it is not only interesting to be able to hear your constructive suggestions about the program itself, but it is obviously very exciting to sit here and listen to the things you are doing that hold a lot of different kinds of potential for different areas.

Let me turn to Senator Nickles first.

Senator **Nickles**. Thank you, Mr. Chairman.

I just have a couple of quick comments. I will echo your thoughts, though. It was interesting to hear how three different applications have taken off in three different directions and come up with some exciting new technology.

Dr. Platt, I think you mentioned that you had received more than anybody else in New York in the program?

Dr. **Platt**. In New York State, that is correct.

Senator **Nickles**. How much have you received?

Dr. **Platt**. We received, all told, four phase I's and one phase II.

Senator **Nickles**. The total amount would be what?

Dr. **Platt**. A total amount of approximately $50,000 each for the phase I and $180,000 for that phase II.

Senator **Nickles**. You have only had one phase II?

Dr. **Platt**. At this particular point. There will be others, I hope, coming through shortly.

Senator **Nickles**. And your company was started in 1981?

Dr. **Platt**. That is correct, 1981.

Senator **Nickles**. Would you be doing these types of things if we didn't have the program?

Dr. **Platt**. Probably not, because this is a situation that allows a small company to literally be a David against the Goliaths out there. It gives them a chance to move quickly and opportunistically against the very large corporations.

Senator **Nickles**. Are the large drug manufacturers doing this same type of research right now?

Dr. **Platt**. Not exactly the same, but it takes them so much longer to get to the marketplace. We can get there much faster than they can, for a lot less money.

Senator **Nickles**. Dr. Koerner, the same thing. You have some interesting technology, talking about taking sawdust and some of the coal wastes and trying to make that into a useful fuel. Are the large companies trying to move forward with this type of technology?

Dr. **Koerner**. We are not aware of too many of them.

Senator **Nickles**. Is it marketable?

Dr. **Koerner**. We think so. We have gotten an awful lot of inquiries from the small amount of press that has been out on it, basically through the SBIR announcements. From personal contacts with some of the coal companies, we have learned that they have tremendous problems with coal fines. They lose an awful lot of their production because the people will not buy the fines; they cannot handle them. They get in their equipment, they get in their gears, they lose them all over the ground, and they just don't want them.

And so, when you either wash coal or you grind coal, you get a certain amount of fines, and it is just a lost resource. There are literally millions of tons of coal fines lying around this country in old wash pits all through the Eastern coal mine regions and through Indiana, Kentucky, Illinois, Missouri, Oklahoma, Arkansas. When you washed the coal, all the fines went with them. Now they have just covered them up. Now they are causing pollution problems. The water rains on it, and now we are getting acid waters.

Senator NICKLES. Your phase II, which was $490,000 or something like that, are you building the pilot plant with that?

Dr. KOERNER. Yes, sir.

Senator NICKLES. How expensive is the entire pilot project? Is that going to cover 100 percent of the cost?

Dr. KOERNER. Yes. The equipment is costing in the neighborhood of $200,000, and that was one of the problems I had with the funding, with the borrowing from the bankers, because we have some fairly big-ticket items here that you have to put up like 50 percent of the amount of money when you order the equipment. When you start ordering a $50,000 or $100,000 piece of equipment, they want half of it right now when you place the order.

Senator NICKLES. Now, you were working on this long before the SBIR came along, or is that——

Dr. KOERNER. No, sir. We had worked on the hydrolyzing of the cellulose to produce a cattle feed, and that was done in the 1970's, and there were actually some plants built in Oklahoma and Arkansas to do this, and they took waste sawdust, cooked it, converted it into sugars, and they fed this to cattle as cattle feed. This was all well and good until corn went to $2 a bushel; then it didn't pay to do it anymore.

But we realized that we had a material that would bind very well, and that is what got us started with the coal. We knew there was a problem, and we submitted it to DOE.

Senator NICKLES. Where is your pilot plant going to be built?

Dr. KOERNER. We are not sure yet. We are going to put it together in Oklahoma City originally, and then we are going to move it to the site.

There is another problem in that, with the coal mining laws the way they are, if we go onto a coal mine site, we need to go through the complete permitting process because of the Surface Mine Act. So we will not be at a coal mine; we can guarantee you that. We will be outside of it. We can bring coal to it and pellet it.

Senator NICKLES. A quick question for the Franklins, and I appreciate the chairman's indulgence.

You mentioned there were six companies that are involved in this type of hearing aid. One of the other companies—or, I guess, your company and one other company—has participated in the program. The other four, are they large companies?

Dr. FRANKLIN. No. One of them is Siemens of Germany, who pretty much got into it after we did, and it seemed to be a response to our device. The word is, I don't think that they are proceeding very much with their developments at this point.

Senator NICKLES. The other companies, are they domestic?

Dr. FRANKLIN. No. One is Israeli, one is Danish, and one is Swedish.

Senator NICKLES. Mr. Chairman, thank you very much, and I appreciate our panelists' cooperation today.

Senator KERRY. Thank you, Senator Nickles, very much.

I would like to ask you a number of different kinds of questions, maybe some practical ones. But let me just ask at the outset, Dr. Platt, I was interested—you said you have a joint venture going with China?

Dr. PLATT. We have started discussions with China.

Senator KERRY. Is that as a consequence of the SBIR involvement?

Dr. PLATT. Oh, no.

Senator KERRY. That is totally separate?

Dr. PLATT. That is totally separate.

Senator KERRY. That is merely a description of your company.

Dr. PLATT. That is correct.

Senator KERRY. All right.

Sort of on a practical side, so that we can kind of get at the ups and downs of this program—and you have been helpful with some of your suggestions sort of on a macro level, all of you—I would like to ask—you know, we are always hearing about Government involvement in this and redtape, difficulties, hard-to-get answers. Have any of those kinds of traditional rubrics of dealing with the process confronted any of you in your efforts here? Would you say there have been undue delays or difficulties in processing of your requests, anything of that sort?

Dr. PLATT. Generally, I would say no. I think when one files for this sort of thing, certain inspections and certain criteria have to be met, and this all does take time. Generally speaking, I would say that there have been no delays.

I would commend New York State for their Matching Dollar Program, because I think that that is a valuable thing to have in a program like this where there is usually a 6-month delay by the time the first phase ends and the second phase starts. And, as has been pointed out by Dr. Franklin, that is a difficult period to hold onto people, to keep the project active and moving. I think something like that is really helpful.

Senator KERRY. Would you, Dr. Platt and Dr. Koerner, describe in the way that the Franklins have your market as being so limited that this was really an only source of funding? Or do you feel it was an available source?

Dr. PLATT. I would look at it as conceptual sources. We have endeavored to try concepts that other people would not try because they said they were too far out and they are not worth trying, and that is what I would thank the SBIR for, and that is for supporting this innovative approach that we have brought to several problems.

That I thank them for and I am very grateful for. If we really have any great success in the world, I think I would credit much of that to being able to be innovative when everyone else was saying, Let's go the other way.

Senator KERRY. Did any of you have any restraint, personally and professionally, in wanting to take the small amount of money that is involved and, in a sense, surface your ideas for that small amount of money with the potential that someone else with more money or some other country with a larger R&D effort might kind of undercut you or come in with a faster research program? Did that ever enter into your thinking?

Dr. **Platt**. Not me, personally.

Dr. **Koerner**. No.

Dr. **Franklin**. Not personally.

Senator **Kerry**. There was no sense of that.

I am intrigued, Dr. Franklin, by the fact that there are suddenly now six companies in this, and yet you are describing a market which, by your definition, is so limited. How does that square?

Dr. **Franklin**. I am not sure how it happened. In one case, in the case of the Swedish entry, the gentleman who did the work is primarily an educator, and he built his device out of off-the-shelf items with really not a great deal of research. He had been involved with the Australian Government in doing some work. He handed his device off to a company in Sweden that is selling it.

The other companies I really don't understand. I understand when Siemens, in particular, came in. They had a market requirement to fulfill in Europe. In Europe, most of the bidding on aids for the hearing impaired is done by school district's where a company will come in and bid, and they needed something to complete their line.

The other companies are really a mystery, and it seems highly unlikely. There were several others who put out prospectuses that have not appeared on the market. I think it is highly unlikely that all of these companies can be successful.

Senator **Kerry**. What is the potential in this for quick and easy reverse engineering?

Dr. **Franklin**. Well, we have a patent at this time on this device and have applied for a patent on the transducer. They seem to be the two major patents in the field right now. One of them, the one for the transducer, if it becomes a patent, came from SBIR. Several of these other companies are now negotiating with us for patent rights.

As far as could they do reverse engineering, the answer is yes. Would it be worth their while? It is hard to see. I think that anybody who has really done a business plan and looked at this field doesn't understand why all these companies are doing what they are doing. It doesn't make very much sense.

Senator **Kerry**. Would each of you agree that there are spinoffs or ancillary products as a potential outgrowth of each of your areas of current research?

Dr. **Franklin**. Oh, yes.

Dr. **Koerner**. Yes, there are.

Dr. **Platt**. Very much so.

Senator **Kerry**. Have any of you felt a so-called intrusion in the monitoring process at all?

Dr. **Koerner**. I would say, to speak to the DOE involvement that we have, we have had absolutely no problem at all. We are assigned a project manager. He did visit us, and we talk to him on the phone occasionally, but that is the limit of his involvement. We get absolutely no interference from DOE.

Dr. **Franklin**. We have had great support and a seemingly good relationship. We have been very pleased with the support from NIH.

Senator KERRY. Maybe each of you can give me a quick breakdown. What is the percentage of Federal investment currently in your research project versus private at this point? Dr. Platt?

Dr. PLATT. Oh, perhaps 20 to 30 percent Federal at this particular point.

Senator KERRY. And is the rest all equity, private investor, or what is the form?

Dr. PLATT. Well, at this particular point, we have no major stockholders in terms of industrial firms. It is all small investor, so to speak.

Senator KERRY. And Dr. Koerner?

Dr. KOERNER. This project represents approximately 25 percent of our revenues, but we are in the consulting business and also have an analytical laboratory, so they bring in revenues.

Senator KERRY. Could you have proceeded without the SBIR?

Dr. KOERNER. No, sir. We would not have done this project.

Senator KERRY. And Mr. Franklin?

Dr. FRANKLIN. It is about 40 percent of our cash-flow, but it really represents something close to 100 percent of our investment.

Senator KERRY. Of the investment.

Dr. FRANKLIN. Of our research.

Senator KERRY. Now, you had started—before the SBIR Program came into effect, you were already producing this particular——

Dr. FRANKLIN. Not with this——

Senator KERRY. Not with that, right. So where did that come from, that funding?

Mrs. FRANKLIN. Us.

Senator KERRY. That came from you.

Dr. FRANKLIN. We have been interested in this for a very long time. We raised something less than $10,000 from ourselves and from these people at MIT and Children's Hospital, and that pretty much was what we did in prior times, plus our own sweat equity.

Senator KERRY. Do I understand that there is sort of unanimity amongst you that perhaps the most critical problem, if we were going to summarize problems of this panel, the phase lag is a serious problem, except where a State like New York can make up the differences?

Dr. FRANKLIN. Yes.

Dr. KOERNER. Yes.

Dr. PLATT. Right.

Senator KERRY. And perhaps we should consider revamping that. And, second, if there were any other complaint, it might be an availability of greater amounts of research money. Is that fair?

Dr. PLATT. That would be true because, although the amounts seem substantial when one says $50,000 or $500,000, when you are doing research, that sort of money goes very quickly, very quickly.

Senator KERRY. What response, if any, would any of you make to the assertion that this somehow might give a small business an advantage over the rest of the industrial and research community? Is that something we should be concerned about?

Dr. PLATT. I think so. I think so, definitely, because otherwise these particular projects would be prioritized by much larger companies, and things of value would take much longer to reach the marketplace than if a smaller company could not participate in it and attempt to make their mark with it; for example, the particular device that Dr. Franklin has.

Dr. KOERNER. I think, further, to—I don't know if that was the correct answer to your question or not. [Laughter.]

I think that a lot of the projects that are being accomplished under the SBIR simply wouldn't be done, because the big industry is not interested in them.

Dr. PLATT. They are small; they are just kept on the side.

Dr. KOERNER. Yes.

Senator KERRY. Because, for time expended, effort, energy, there is no return for them?

Dr. KOERNER. That is right

Dr. FRANKLIN. Yes.

Senator KERRY. Do you almost have to be working out of your home, in similar startup circumstances, to make the SBIR worthwhile in that sense?

Dr. FRANKLIN. I don't think that is true. I think that that was true for us, but I don't think that is significant.

Senator KERRY. Smallness doesn't mean supersmall?

Dr. FRANKLIN. I still think that the idea of having these groups which perhaps are supported—I think there are two States who are doing this, Pennsylvania and Connecticut, maybe, that actually have set up regional places where people can go in and actually get help in managing their company as they go through it. I think it is an extremely good idea.

Senator KERRY. Would each of you support the notion that it is appropriate for the awarding agency to make judgments of its own about projects it wishes to research which may not have broadscale commercial application such as I would think you might characterize yours?

Dr. FRANKLIN. I don't understand the question.

Senator KERRY. Well, there may be areas in which the ultimate commercial prospect is not enormous, and yet, as with your tactile hearing supplement, there is a different kind of benefit which may or may not be worthwhile. I mean, do you think it is appropriate for this program to be making those kinds of judgments?

Dr. FRANKLIN. Oh, absolutely. I think that the amount of money that—if we are able, as a group, to actually build something that eventually becomes an artificial ear, so to speak, that the savings to the economy are going to be huge. I think they already are. I think that if we just looked at the—we have between 400 and 500 aids out there, mostly on children. I think if you looked at the potential saving just from those 400 or 500 kids, it would certainly be 10 times more than the $500,000 that has been spent over, say, a 20-year period in their lives.

Senator KERRY. Did any of you apply for funding from other sources?

Dr. FRANKLIN. Yes.

Senator KERRY. You are the only ones? You didn't, Dr. Koerner?

Dr. KOERNER. Not for this project.

Senator KERRY. How would [illegible] compare the standards applied by the SBIR Program versus t[illegible] others that you sought to seek from?

Dr. PLATT. The SBIR is very good.

Dr. FRANKLIN. We got this one.

Senator KERRY. You got this one, so it is terrific, right? [Laughter.]

Dr. PLATT. That is about right.

Dr. FRANKLIN. Well, this was much more focused. This, I think, gave us a chance to describe what we wanted to do in terms other than commercial. For example, when we tried to get commercial funds, it very quickly reduced, to, are we going to make any money on this? Here that was--I don't think it was not an issue—certainly the question was asked and we had to answer it—but it certainly wasn't the major consideration.

Senator KERRY. Let me just ask generally, is there any comment which any of you would wish to make that has been prompted by one of my questions but which you haven't had a chance to answer at this point, before we move into the next panel, or anything you would like to add to your testimony?

[No response.]

Senator KERRY. If not, I would like to thank you very, very much on behalf of Senator Rudman, our chairman, who is not here yet.

Let me just explain to you—and I am sort of debating how to proceed here—that Senator Rudman is at the White House at a meeting and has called to say that that meeting is going a little bit longer than he anticipated, but he will be here.

I have a meeting that I have to go to involving another committee that I am on at 11 o'clock, and I am willing to try to cut in a little bit, but I think we are going to have to recess for a period of time to enable Senator Rudman to get here to cover because of my prior commitment.

So why don't we begin the next process? I will go a little bit into the next half-hour with the hopes that he may suddenly appear by Presidential intervention, if not divine, and then be prepared for the fact that I may have to call a recess at that point in time, and I hope you will bear with me with that understanding. But I know the Senator wants to hear that next panel, as much of it as he can, and he will have his own questions, and I think it is important that he be given that opportunity, so if you could bear with us, we would appreciate it.

So thank you very, very much to all of you for sharing with us your experiences and your feelings about this program. I think it is very helpful. I think each of your recommendations about a percentage increase, about an extension to other departments, about the lowering of the amount of the threshold from $100 million to $20 million, whatever the level, and the phase I/phase II lag issue, are all important contributions to the debate, and we will, needless to say, spend time thinking about those and responding to them. So I thank you very, very much for your contribution to this effort.

Why don't we shift panels here, and we can at least begin with some opening statements.

I would like to welcome the second panel, and I gather you were all back there and listening, so I appreciate your indulgence with my time problem and Senator Rudman's, and I hope you will understand that we will have to intervene here.

I gather that Mr. Stephen Andrade has a time problem, also, so we will try to lead off with his testimony and go from there. He is the director of the Small Business Innovation Office, Advanced Technology Center, and comes to us from Pennsylvania.

Mr. Lawrence Barker, Jr., is the principal program manager for the New York State Science and Technology Foundation, from Albany, NY.

I am delighted to welcome Mr. Wade Blackman, who is the vice president of American Research and Development, Inc., from Boston, MA. He is no stranger to this process or to the whole field of engineering, financial, and operating management experience, which he has been involved in for a long period of time. Mr. Blackman, we are very happy to welcome you here.

So, if we could, we will start off with Mr. Andrade. As I say, about 10 after, I am going to have to recess, and, hopefully, it will be a minimal recess at that point in time.

Thank you.

STATEMENT OF STEPHEN P. ANDRADE, DIRECTOR, SMALL BUSINESS INNOVATION OFFICE, ADVANCED TECHNOLOGY CENTER OF SOUTHEASTERN PENNSYLVANIA

Mr. ANDRADE. Thank you. I appreciate this opportunity, Mr. Chairman, to present our experience in working with companies on this program.

I am here representing the Small Business Innovation Office, which is actually based at the University City Science Center in Philadelphia and is one of the early incubators in the country. It was established in 1964. We are funded in part by the city of Philadelphia and by the Ben Franklin Partnership to provide assistance on a regional basis to small firms pursuing SBIR and other R&D financing for new ideas.

Our mission, I think, is very similar to one of the purposes of the SBIR Program: We are interested in helping small companies and new ventures grow by way of commercializing new technology. We, like many other States, are very much interested in their job generation potential, which many studies have indicated is very much more productive than other sources of jobs, and important to the regional economy.

Our program started roughly the same time as the SBIR Program came on line, beginning in calendar year 1983, and we have been assisting firms by, first of all, trying to get new firms involved in the program. This is a program that benefits, I think, from the entry of new actors in a constant process, and it is addressed to facilitate those new relationships on an ongoing basis.

So, in part, our mission is to get the word out on a regional basis to firms that may not know what the letters stand for and may not know about the opportunities. And we are typically involved in working with individual firms to prepare competitive proposals, advising them as to whether it makes sense for them to pursue this source of funding as opposed to private funding, et cetera, in the context of trying to get new ideas developed and commercialized.

Senator KERRY. Do they find you or do you find them?

Mr. ANDRADE. More frequently, they are finding us. We do make an effort to get the word out through the media and various other forms of networking, et cetera, running seminars and briefings on the program, but in fact we have found the most powerful means of communication is word of mouth among professionals and among peers, among other entrepreneurs.

They support each other, also, and I think that is an important dynamic that you miss if you look at the numbers. Firms share information about their experiences when they win awards, when they have problems, and they, other than sharing proprietary information, are very supportive of one another if they can be put in touch with one another, and that is another role we play, by saying, "Well, you should talk to so-and-so because they went through this process 6 months ago or a year ago with a specific agency, and that might be helpful to you. We can tell you a little bit, but I think they will be more helpful because they were involved directly with the agency." So we fill those roles and also work with individual firms.

In the past 2 years, since we have existed as a formal program, we have worked individually with about 30 to 50 firms per year, typically developing phase I proposals. Some of those do not submit because of time constraints or other decisionmaking, but we work with them on a 1 to-1 basis.

Of those clients that have actually submitted, we have had 15 awards totaling about $1.2 million, all but one of which has been a phase I award. Of the 11 firms that have received awards as a result of that assistance, every one, to my knowledge, had not had previous Federal contracting experience as a firm. A lot of those are new startup firms—firms that have started since 1980 or so. But our mission and our niche has been to get new actors involved in the field and to help transfer the expertise of firms that have had experience to others through networking and other forms of communication. Pennsylvania as a State has benefited from this program. Fiscal year 1984 is the most recent year for which complete information is available, and if you look at the phase I awards, Pennsylvania is now No. 4 among the States, and the percentage of awards has increased from what was less than 1 percent of the National Science Foundation's awards prior to the full legislation, to now roughly about 5 percent.

So we see it as growth in that way, but I think we also regard it as somewhat other than a zero sum game and something that is not really competition among the States. I think that our growth comes primarily from internal resources, from firms and entrepreneurs that are locally based, and we are anxious to see that they get adequate resources so that they can have an opportunity to compete in the marketplace. The Federal program is an important part of that because Federal spending is as much as half of all R&D investment in this country, and I think that it has a certain role to play in helping to set the stage for private investment for commercialization, et cetera.

Based on our experience, I would like to, first of all, give you just an example of what we can do for a specific firm that we helped win an award and then move into just a few recommendations that we have, based on our experience in working with firms.

The one example in which we were able to help was a small firm by the name of C.A. Electronics, which is located in Exton, PA, outside of Philadelphia. They are about a 15-member firm that does both electronic development and software development. They came to us with about 2 months to go before a due date for the National Science Foundation and had an idea for inspecting particles in the packaging of pharmaceuticals. but were looking for someone to complement their team with an expertise in sensing technologies.

With our relationships through the Ben Franklin Partnership Program that involves a consortium of universities, we were able to get them connected with Drexel University, with an engineering professor whose background and expertise is in ultrasonics. And with that additional part of the proposal in place, they were able to submit the proposal and win funding at around $40,000.

The project is succeeding in terms of its phase I milestones and is complete and now in the process of waiting for the submitting of the phase II application, waiting for the typical 6-month gap and trying to seek the outside follow-on financing that they are interested in to help commercialize this. This firm will transfer this technology to another operation—that is, a pharmaceutical operation—to apply it in its production processes, and it is currently looking for those kinds of sources of additional capital that are required. We have seen on the university side—the universities were originally antagonistic toward this program—that there have been a lot of examples where, in specific proposals, there have been new relationships formed with university professors, and the university administrators are beginning to see that this is a source of other income besides just the competition for Federal dollars, because in those new relationships, if a project succeeds, the company is going to have other investment coming in which will also be used in part to fund sponsored research at a university.

In some cases it provides a window for the university to transfer technology off the campus into the private sector and for the university to realize some benefits in the form of licensing, et cetera, for those patents. So there are benefits to the university as well as to individual faculty members, who are not typically business people, but are motivated in part by seeing that their ideas are put into practice. This provides a window for that to happen without the universities losing valuable faculty.

In terms of recommendations, I would just say that more emphasis should be placed on the follow-on funding requirement. I think only one agency really places a strong emphasis on that as a criterion for picking projects in phase II, and I think more emphasis should be placed following the model of the National Science Foundation.

Second, there should be more emphasis in the criteria on the business and commercial applications. I think that you don't want to stray from the mission of the agencies but, by the same token, I don't think the scientists are the only perspective that should be provided for in the review of projects. I think that there should also be greater attention paid to the commercial potential and applications of these technologies in the marketplace.

Senator **Kerry**. Greater emphasis by the awarding agency on that?

Mr. **Andrade**. Not necessarily using internal people but, in some cases, using the perspective of venture capitalists or others that can contribute to the evaluation of an idea which has both a technical side to it as well as a business side.

In addition, I think that it is clear that working with small firms is a labor-intensive process. We find that ourselves, and the agencies that manage this program, the people, the SBIR Program managers, are very highly motivated and, I think, have done a tremendous job within the system. But they don't have, in my opinion, sufficient administrative and informational support to really carry it out on a first-class basis. So I think that more resources should be attended to that, and I think that there will be benefits that can come from that.

I think the funding gap has been addressed earlier. There are various ways in which that might be addressed other than expecting States to provide bridge financing. We do that on an informal basis, whereas New York does it on a more structured basis. But I think that there are other designs.

The 6-month wait before a firm gets funded in phase I and for what then is a 6-month period of funding and followed by another 6-month wait for follow-on funding in phase II, that is a lot of expense and time and effort, and perhaps the funding level and the time allowed for Phase I can be enlarged to compensate for that.

I also think that the Phase II decisions should be made more quickly than 6 months. Typically, you are talking about funding 1 out of 3 proposals, not 1 out of 10 that occurs in phase I, so I think that there is enough experience with the project such that the decisionmaking could be accelerated.

I think there also should be more clearly defined ways of bubbling up new ideas, because I think the agencies would even admit that they are not the only source of all new topics that make sense for their mission. And there should be a more clearly defined mechanism for bubbling up creative ideas that come from the firms that at the same time make sense for the agencies.

Finally, I think that in the case of one agency, the largest, which has about half the funding in the program, the Department of Defense, they should consider—and I understand there is an administrative cost to this—but they should consider soliciting proposals on a more than once-a-year basis. The second largest agency, the NIH [National Institutes of Health] solicits three times a year, and we find that more firms are able to participate and enter the field on an ongoing basis with that with just the once-a-year DOD solicitation that generally occurs right after Christmas, and it is hard for people to enter in at that point.

I would also say that at this point, with the program scheduled to enter its last full year of authorization—in other words, fiscal year 1987 will be the final year in which agencies will be formally soliciting proposals before the end of the authorization—I would be concerned that all agencies continue to solicit phase I proposals in that fiscal year. I don't have good information, but I would be concerned that the agencies not anticipate that this program is going to be discontinued and therefore begin to sort of wind down for it. I would hope that they continue with the assumption that it is going to continue until they hear otherwise.

[The prepared statement of Mr. Andrade follows:]

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM OVERSIGHT HEARING
March 11, 1986
Before the Senate Subcommittee on Innovation and Technology
U.S. Senate Small Business Committee

Comments by: Stephen P. Andrade
Director, Small Business Innovation Office,
Advanced Technology Center of Southeastern Pennsylvania

INTRODUCTION

Mr. Chairman, other members of the committee, I am here as the Director of the Small Business Innovation Office to present our experience in assisting firms on a regional basis with the SBIR program. In addition, based on that experience, I would offer suggestions for your consideration toward improving this important and valuable program.

MISSION

The Small Business Innovation Office is a joint City-State program initiated in 1983 with the support of Pennsylvania's Ben Franklin Partnership and the City of Philadelphia. It is based at the University City Science Center in Philadelphia, a non-profit economic development corporation which includes the nation's first urban research park, and which is owned by 28 universities, colleges and health institutions in the region.

While the Small Business Innovation Office specifically focuses on assisting small and start-up companies in pursuing Research and Development financing, it operates in this larger context. Through the Ben Franklin Partnership and its regional Advanced Technology Center, an integrated set of entrepreneurial development services is provided to 500 small firms annually.

The mission of the Small Business Innovation Office is to build the capacity of small firms in southeastern Pennsylvania to effectively compete for federal, state and private funding in order to develop and commercialize new technologies. To this end, we play a number of roles:

- *information center and network developer*, making new firms aware of SBIR opportunities through the media, regional newsletters, seminars, targeted mailings and telephone contacts as well as professional, financial and entrepreneurial networks. This has included disseminating prior and current solicitations locally, on demand.

- *direct assistance provider*, working individually with about 30-50 small firms and entrepreneurs in developing proposals each year, we provide the following services:

- assessment of the proposed project's applicability to the SBIR program;
- technical writing and proposal refinement.
- on-line literature searches at a local university library.
- technical proposal reviews and referrals to recognized university experts to enhance a proposal.
- access to donated professional, legal and accounting services related to patents and government contracting; and
- advice on alternative seed funding possibilities.

A SUCCESS STORY

We have found that publicized success can build on itself. To date, we have been involved in 15 successful SBIR proposals, resulting in the awarding of $1.2 million to 11 firms. In addition, through the Ben Franklin Partnership, the universities have been very interested and open to collaborating with small firms in our region.

To cite an example, L.A. Electronics, (a small electronics and computer software firm) approached us with a need for a university expert in sensor technology to complement their idea for inspecting for particulates in the production of pharmaceuticals. Through our relationships with Drexel University, we were quickly able to connect the firm with an expert in ultra-sonics. The firm subsequently won a $40,000 Phase I award from the National Science Foundation. The project is proceeding successfully, and we have subsequently been involved in advising the firm on follow-on private funding to complement its Phase II proposal.

RECOMMENDATIONS

While the SBIR program has afforded many new small technical firms the opportunity to establish new relationships with federal

R&D agencies, and deserves to be continued, we would offer the following suggestions and concerns for its improvement.

o In keeping with the program's objective to stimulate job creation through the commercialization of innovative technology, the private follow-on funding requirement should be strengthened. The National Science Foundation's approach here, which has been leveraging 8 to 9 dollars of private investment for each federal dollar, should be transferred to the other SBIR agencies.

o Working with small firms, although very rewarding, is very labor intensive. More information and administrative resources should be brought to bear within participating agencies to improve the timely flow of accurate information, solicitations and the processing of decisions and contracts.

o Alternative ways of addressing the funding gap between Phases I & II, as well as the high start-up costs of Phase I should be considered. Phase I maximums could be enlarged to $75,000 in some cases. [illegible] performance incentives should be offered to [illegible] expedite Phase II decisions.

o More clearly defined ways of [illegible] new innovative topic ideas from small firms for inclusion in future solicitations should be developed.

o The Department of Defense, with a [illegible] of all SBIR funding, should [illegible] topics than awards on a [illegible] year, and [illegible] by providing more opportunities for small firms [illegible] more than once a year, as the [illegible] agency [illegible] already does.

Finally, I would like to identify a concern for the program [illegible] first full year of authorization [illegible]. To avoid a potential hiccup in the program, all participating agencies should be strongly encouraged to continue to accept Phase I proposals in [illegible], pending the reauthorization decision which we [illegible] will come in a timely manner.

Senator Kerry. I thank you very much, Mr. Andrade. That is very helpful, and I appreciate the additional suggestions to what we have heard earlier, and I think they are good suggestions.

Let me just comment for myself as I depart here that I know, Mr. Blackman, that you are going to address this to a certain degree, but I have been struck personally by the extraordinary lack of attention that this country has given to this whole issue of innovation. We talk about it and we pat ourselves on the back and we feel very good about our technological superiority in many areas, but the reality is, if you look at the statistics and recognize the changing marketplace in the world and the new definition of competition in the world, that it is old stuff. We are not doing what we need to do to keep up by any sense of the imagination.

When I compare what we are talking about doing to what the Japanese are in fact and other countries are doing to close that technological gap, and you look at the diminishment of American technological product over the last years, it is a very serious concern. And when you measure—and these are all becoming cliches almost today—but when you measure the number of lawyers versus engineers and other things that we produce in America, we are on the wrong track.

When I was Lieutenant Governor of Massachusetts, I served on the Mass Technology Development Corp., and we as a State put venture capital money into private efforts, some of which I am proud to say now are on the big board down in New York, and we have created more than 6,000 jobs, and as soon as they can float on their own, we get out of the business because it is not something we think Government ought to be in, in an equity position. But it is a needed tool in terms of capital formation and job creation.

I applaud you for being here today to share those thoughts with us.

I, unfortunately, have got to go to another meeting involving some small business innovation research in Nicaragua and an effort by the Contras to overthrow a government. [Laughter.]

Senator Trible. Perhaps, Senator Kerry, you should stay here. [Laughter.]

Senator Kerry. Aha! Maybe not. I think I would be better served there.

Senator Trible has joined us, and rather than recess the meeting, why don't I turn the Chair over to him so that you can continue?

Senator Trible. I will do it.

Senator Kerry. I am sure that he will bring Senator Rudman up to date.

Thank you very much, panel. Thank you, Senator.

Senator Trible [acting chairman]. Thank you.

Gentlemen, where are we? Has each of you had a chance to testify or not? Just the one?

Mr. Barker. Just Mr. Andrade.

Senator Trible. As you will. Mr. Barker, would you like to go next?

STATEMENT OF LAWRENCE L. BARKER, PRINCIPAL PROGRAM MANAGER, NEW YORK STATE SCIENCE AND TECHNOLOGY FOUNDATION, ALBANY, NY

Mr. **Barker**. Thank you, Senator.

My name is Lawrence Barker. I am the principal program manager with the New York State Science and Technology Foundation in Albany.

I would like to give you a brief summary of our remarks this morning, an overview of our agency, what the Science and Technology Foundation is and what it does, the unique New York State SBIR matching program, a summary of its origins and its operations and its accomplishments.

The New York State Science and Technology Foundation is a public benefit corporation originally legislated in 1963. Its original purpose was to act as a State-level mirror image of the National Science Foundation in that we supported basic research, primarily worked with the university community, and sought to advance the state of technological development and education in our universities. For the greater part of 20 years, that was the foundation's role.

With the advent and increasing national interest in high-technology industries and the rise in the amount of interstate competition for these industries in the late 1970's and early 1980's, significant legislation was passed which in effect revitalized and reconstituted the Science and Technology Foundation. It became an economic development organization focused on the development and nurturing of entrepreneurs and high-technology industries in the State.

One of our major programs is called the Centers for Advanced Technology. We fund seven major public and private university research centers in the State with public dollars required to be matched by private dollars to focus on applied research for commercial industrial purposes. The "sea change" here in all of these programs is that we are trying to move toward closer university-industry cooperation and toward development of products and processes which will end up in the marketplace creating new businesses and additional jobs in our State.

The Small Business Innovation Research Program is one of our major programs at the Science and Technology Foundation. Our current purposes are: New technology development, providing access to new technologies to all of New York State's firms, including its older, established manufacturing firms who are in dire straits and in need of new technologies to innovate themselves and to become more productive. We also support the conception, research, and development of new products.

To discuss the New York State SBIR Program, I would like to give you some very brief background. Beginning immediately upon enactment of the Federal SBIR statute, New York State began a series of outreach programs which were meant to tell New York State high-technology firms about the Federal program and to describe the opportunity it offered.

In 1982 and 1983, we conducted workshops, did significant mailings and publicity on the Federal program to try to get more New York State companies to participate. Our record of participation in

1983 was not very good. New York State small businesses involved in the SBIR Program won a total of 25 new phase I awards. That placed us, in absolute numbers, 9th in the Nation, but what was really of concern to New York State's leadership was that, on a demographic basis, we would have ranked 30th among the 50 States in terms of our population and our high-technology resources.

There was a recognition not only that New York industry could do better but that the SBIR opportunity that had been presented to us by the Congress was not being taken advantage of. A lot of discussions went on in both houses of our legislature—in our Assembly and in our Senate—during late 1983 and early 1984.

At that time, the Federal program was entering its second year; New York State's record was improving, but not much; and we still felt that because of the nature of high-technology businesses—the formation rate was very high and the invisibility factor of new, small high-technology businesses is incredible—finding them is a difficult job and then telling them about the SBIR Program was an equally difficult job for us to do.

Another observation that was made even then was with respect to the gap between the phase I and phase II components of the Federal program. Small firms, even winning phase I projects, were finding it extremely difficult to stay alive and to survive during the long period between the end of their phase I work and, hopefully, the startup of phase II projects.

A key element of our thinking behind the New York State program was to bridge that gap. It was not in the sense that New York State wanted to buy a small firm's research by providing it additional funds; New York State wanted to invest, if you will, in that company's future. We found that SBIR, the Federal program, met both research and development and economic development needs.

Our legislation, which is referred to as the New York State Small Business Innovation Research Promotion Act—and that is a key word—was signed into law by Gov. Mario Cuomo on July 19, 1984. It essentially has two elements. One is publicity, of equal importance to the matching contracts program. And, as Mr. Andrade has said, you need to get the word out and find out who the companies are and tell them what is waiting there for them. The word I use throughout my remarks is opportunity. The opportunity is there, but it has to be taken.

We increased our outreach efforts. We increased our workshops. We have now had over 600 small high-technology firms physically attend workshops and seminars that not only tell them about the Federal and New York State programs but also give them training and assistance in how to write high quality proposals.

A major problem for entrepreneurs seeking to take advantage of the Federal SBIR Program is that they know their field very well—they are technological experts—or they have got a brand new idea that nobody has thought of yet. However, they are not grantsmen. They don't know how to write a winning proposal in terms of not the "what" of what it is they want to do but the "how" to describe it.

So we in New York—and, I know, in other States—have put a lot of resources into what we call technical assistance to help our entrepreneurs learn how to write winning proposals and to describe their technology favorably.

In addition to the publicity component, we have a unique matching contracts program which is funded by a New York State legislative appropriation. Beginning in 1984, we were appropriated $500,000 to issue matching contracts to eligible New York State firms. We define eligibility in New York State in a noncompetitive way. By that, we mean we rely upon the very thorough and very rigorous Federal agency review process to bring the cream to the top. The best proposals are the ones that get funded.

If a New York State firm is successful in winning a Federal agency SBIR phase I project, then they are eligible to receive matching funds from New York State up to the amount of either $50,000 or the full amount of their Federal phase I project, whichever is less.

What else do they have to do to receive these funds? They have to have successfully completed their phase I project. They have to have filed a final report and have it accepted and to show evidence of willingness to participate and continue in the Federal program and to go after the big dollars in phase II. They have to have properly filed a complete phase II application.

At that time—they have finished their phase I and applied for phase II, and the waiting game begins—we then come in with our matching funds. We ask them to certify that they are a small business firm, in our case with 250 or fewer employees rather than the Federal standard of 500; that their principal place of business is in New York State; that they will not subcontract out of their company more than one-third of the funds, and that they will not contract any of the New York State funds out of the State.

That is essentially it; that is what we require. We ask the companies to submit a brief research proposal to us. We tell them, "Take advantage of the work you have already done. If you want to get involved in a different application of the technology or topic that you worked on for phase I for a Federal agency, then you can do that."

We have had cases—let me give you one example, if I may—where firms pursuing federally funded research have utilized and taken advantage of the New York State funds in a positive way to open up new product dimensions.

We have a company in New York that received a phase I contract from NASA to come up with and develop a particulate monitoring device for planetary atmospheres in space, literally. They have found, using the New York State matching funds in the interim between phases I and II, that there is a significant commercial potential for this device in computer room environments. They are currently negotiating with the largest main frame computer manufacturer in the world for an equity position in their company and a significant infusion of capital to develop that technology to come up with a particulate monitoring device to eliminate or detect elements in chip manufacturing facilities. There is an excellent example of what we like to help companies do with the matching funds.

We also help companies to be more competitive for phase II. As I said before, we start at the phase I application process. We try to help them obtain what is referred to in the SBIR Program as a phase III financial commitment. In many agencies, particularly in the National Science Foundation, that phase III funding commitment which is to be submitted with a phase II proposal—2 years early, in effect, maybe even 3—is critical for funding of a phase II project.

One of the programs that the New York State Science and Technology Foundation operates is a public sector venture capital fund. Senator Kerry just mentioned a similar organization in the State of Massachusetts. We fund, through equity and/or loans, high-technology companies that are ready to go into manufacturing. We use that fund as a financial source for companies seeking to obtain phase II projects.

Another thing we try to do to help our small firms in terms of financing their work and cash flow problems is that we fund all of our matching contracts on an advance basis. We meter it out; we don't give them 100 percent of the funds up front. But we always see to it that they are working with our money rather than with money they have to raise themselves or finance themselves at high interest rates.

Let me go on and give you a brief summary of where we were and where we feel we are today in terms of SBIR accomplishments. I mentioned earlier than in 1983 New York State firms won a grand total of 25 awards. In fiscal year 1984, that went from 25 to 35. Our matching contracts program did not affect fiscal year 1984 because the legislation was not passed and signed until the end of that fiscal year.

The increase from 25 to 35 is good but if you look at the increase in the size of the Federal SBIR pot, then we barely kept even. Our first year was fiscal year 1985 to sit back, cross our fingers, and hold our breath and see whether this State initiative really was going to help increase New York State's participation.

We have done a survey of all of the Federal agencies, some of which have not officially announced their awards yet, but we feel pretty comfortable in that we have some hard data on how New York State small business high-technology firms have performed. Judging from fiscal year 1984 to fiscal year 1985, New York State firms have won an increase of over 75 percent. Last year our companies won 35 projects. This year we have won 62.

As has been said previously, this is not a zero sum game. We are not out to take away from other States. What each State is out to do is to help its own small business firms specializing in new technologies and innovation. We feel that, in addition to the phase I growth of over 75 percent, we are helping our phase I winners to convert to the much larger phase II projects at a much higher rate. Over 60 percent of our companies are now going on to win $500,000 phase II projects. That is well above the national average.

To date we have funded 35 projects with our matching funds. We have over 100 companies that are eligible to receive matching funds, and they have won a total of over $5 million in Federal SBIR phase I awards. These companies account for between 500 and 1,000 jobs in New York State, and most of those companies are very small operations that we think are excellent investments for growth in the future.

To put it on a Federal-State revenue sharing, whatever you want to call it, basis, to date New York State has invested $1.4 million in our SBIR winners. That money, in terms of Federal return, Federal dollars coming into the State, has realized over $14 million of Federal SBIR phase I and phase II moneys. Again, that is not the whole thing; that is a part of it. But in so doing, we are helping the job development and the new enterprise development processes.

What does the future hold? Our legislation for the New York State SBIR Program is directly tied to the Federal legislation. If the Federal SBIR Program expires and is not renewed, so will the New York State program. We have already reviewed the possibilities of establishing an SBIR-like program which would provide seed capital to New York State's entrepreneurs in the absence of a Federal program.

It would be very difficult for any State, I feel, to put a similar mechanism in place, mainly because of the degree of thoroughness and review that is exercised of these projects, thousands of proposals at the Federal level. In order to screen out the perpetual motion machines from the practical technologies, it would be very difficult for any State to mount that kind of effort.

SBIR provides seed capital, and that is how we promote it to our companies. We say to them, "SBIR offers you the opportunity to acquire no-strings capital. It does not represent taking on debt. It does not represent giving up equity in your company. It is money to further your own business plan and your own development purposes." That is what we think is so special about SBIR.

If I may summarize very briefly, there are several needs that I see continuing: the need to continue to encourage innovation at the national level—it is essential for our survival—the need to maintain U.S. industrial competitiveness; a recognition, and a growing recognition, of the importance of small businesses to this innovation process; the critical need among these small high-technology firms for seed capital.

Most venture capital comes in farther down the road. Most venture capital organizations, and even individual investors, institutional investors, come in at the seven-figure level, not at the $50,000 level. But a $50,000 SBIR investment, in our case matched by another $50,000, and hopefully creating a phase II SBIR investment of $500,000, will provide a firm the stability it needs to grow during the critical high-mortality stage of its existence, the first 2 or 3 years.

We at the State level are convinced that the Federal SBIR Program is meeting all of these needs. The States are leveraging SBIR in many ways: direct financial support, networking assistance, brokering universities and industries together. There is a lot of activity going on that is very beneficial leveraging off the Federal SBIR program.

We, too, have enjoyed excellent cooperation from the Federal agencies, the Small Business Administration and each of the procuring agencies. Their representatives have been very helpful. If I could voice one criticism, I would say that we would like to be able to get our hands on information on not only the successful firms that have applied from our State but the unsuccessful firms. We have other programs that we can use to help them. In some cases, Federal agencies will not disclose that information, even if a company has said, "yes, you may." That is a problem, not a major one, but it is something that would certainly help our efforts if we could obtain that information more readily.

We are finding out that SBIR helps us to locate our own companies in the State. The high-technology entrepreneur in many cases, as I have said before, is invisible. The SBIR process floats them up to us, so we can find out who they are, we can help them get their businesses started, put them in incubators which we have throughout the State, and help them to obtain venture capital.

In summary, we feel that the Federal SBIR Program has created a tremendous opportunity. It is 3 years old. It has taken 3 years to start a full realization at the grass roots level of what that opportunity really means. We strongly recommend that it be continued. To the extent that additional funds could be set aside for small businesses, that would be tremendous. I think the benefit to States and to the Nation as a whole and the return on the investment is significant.

Thank you.

[The prepared statement of Mr. Jones follows:]

STATEMENT OF

H. GRAHAM JONES, EXECUTIVE DIRECTOR

NEW YORK STATE SCIENCE AND TECHNOLOGY FOUNDATION

PRESENTED TO

THE SUBCOMMITTEE ON INNOVATION AND TECHNOLOGY

UNITED STATES SENATE COMMITTEE ON SMALL BUSINESS

WASHINGTON, D.C.

MARCH 11, 1986

Good morning Mr. Chairman, and members of the Subcommittee on Innovation and Technology. I am Lawrence L. Barker, Jr., Principal Program Manager with the New York State Science and Technology Foundation, located in Albany. I am appearing today to present the statement of our Executive Director, Mr. H. Graham Jones, who is not able to appear due to a conflict with today's Board of Directors meeting of the Foundation. I will summarize the statement briefly, and will be glad to answer any questions.

I. Introduction

We were very pleased to receive your invitation to present our views on the importance of innovation and technology in New York State, with particular emphasis on the importance of the Small Business Innovation Research Program to technology-based industrial development. In this statement I will provide an overview of New York State's "high technology" economic development strategies and programs, will describe the historical development and current roles of the Science and Technology Foundation in carrying out the State's objectives, and will outline the purposes, structure and accomplishments of New York's unique Small Business Innovation Research Promotion Program. Our SBIR Program will be explained in its important economic development context.

II. Overview of the New York State Science and Technology Foundation

A. Organization and Purpose

The New York State Science and Technology Foundation is a public benefit corporation created by an Act of the State Legislature in 1963 under the State's Public Authorities Law. The Foundation's main purpose is to promote the economic and social benefits of scientific and technical education and research in New York State. In particular, the Foundation:

- **Supports the conception and development of new technologies which may be relevant to private industry.**

- Facilitates access to recent technology for the benefit of New York companies.

- Promotes the development and manufacture of new commercial products in the State.

The Foundation is expected to pay particular attention to the encouragement of entrepreneurs, the nurture of technology-based start-up companies, and the support of technical outreach to maintain the productivity and competitiveness of established industry. Powers granted to the Foundation include the raising of funds from both public and private sources and the use of those funds for contracts, grants, loans and equity investments. These powers are exercised and the Foundation governed by a board of thirteen members, of whom four are State Agency heads serving ex officio and nine are private sector leaders appointed by the Governor with the consent of the Senate.

B. Development from 1963 - 1981

The Foundation's original concept was to mirror at the State level the purposes of the National Science Foundation. These objectives centered upon support of basic academic research, advancing the "state of the art" in scientific and engineering fields, and increasing the quality of technological education at the post - secondary level. During most of the first two decades of its existence, the Foundation operated one annual research and development grants program, primarily supporting basic research conducted exclusively at educational institutions. At its highest point during this period the Foundation's annual budget was approximately $270,000, with a maximum staff of five, and at times its very existence was in jeopardy due to its limited functions, academic connotations, and other funding priorities.

As New York and the nation entered the 1980's the relationships between innovation and economic development were becoming more and more apparent. Prior emphasis by states on supporting research and development to attract large Federal or corporate-funded centers was shifting to a focus on more direct actions to stimulate the industrial innovation process - including R&D, but not limited to it. National interest in the attraction and fostering of high technology industries began to increase at a rapidly accelerating rate. Intensive interstate competition began for these industries, which offered the promise of low polluting, low infrastructure, high paying, high value added jobs to states and localities. Technology corridors/clusters/valleys, etc. began to form in areas as diverse as California's Silicon Valley (around Stanford University) and in Massachusetts (around Route 128). New York State, with its strong educational and technology industry resources, needed to coordinate and capitalize on its assets in order to avoid missing a tremendous economic opportunity. New York State's leadership in all sectors realized the vital importance of innovation and technology to the future of our economy.

C. Development from 1981 - Present

In response to former Governor Carey's call in 1979 to revitalize the state's Science and Technology Foundation and to refocus its mission toward economic development, a major study of the State's high technology industrial future was commissioned through the Foundation with the Battelle Memorial Institute. This study examined New York's resources and comparative advantages, and recommended that state government initiatives be directed to specific "strength" industries such as medical instruments, biotechnology, electronics, and computer software and hardware engineering. Utilizing the Battelle Study as a seminal document, the Executive and Legislative Branches, with strong support from technology leaders in the private and academic sectors, collaborated on a series of legislative initiatives designed to increase the pace of high technology development and improve New York's entrepreneurial climate. The outcome of this process was a fundamental change in the Foundation's charter, functions and responsibilities, effectively beginning a new generation in its history.

The largest and best known of the Foundation's new "second generation" programs was the Centers for Advanced Technology, whereunder seven of New York's leading public and private academic institutions were competitively selected, and are each offered up to $1 million annually to conduct applied, industrially-oriented research with mandatory matching funds from the private sector. Another unique initiative was the formation in 1982 of the Corporation for Innovation Development, a public sector venture capital fund offering both equity and loan operating capital to new technology firms ready for manufacturing. This program's fund was originally capitalized with a competitive grant from the U.S. Economic Development Administration, matching a state appropriation. Continuing this emphasis through the Administration of Governor Mario M. Cuomo, additional programs in areas such as Regional Technology Development, Small Business Innovation Research (to be later discussed), and expansion of the R&D Grants Program brought the Foundation into the forefront of the state government's economic development activities, confirming and acting upon the importance of innovation and technology to New York's economy.

Beginning in 1984, a "third generation" of additional programs oriented to the manufacturing sector of the State's economy were undertaken, again resulting from both Executive and Legislative actions. From a public policy standpoint, this represented an expansion of economic development emphasis from "high tech" programs and incentives for new enterprise development and job creation to a realization that the supporting structure of New York's economy was continuing to erode due to foreign competition, insufficient capital, declining markets and outmoded products and manufacturing processes. This erosion of manufacturing industry and loss of thousands of jobs would more than eliminate any compensating gains from high technology industrial development, especially in the near term. The need to bring new technologies to our established industries was recognized.

Accordingly, the Foundation was authorized to begin a Productivity Development Program to assist established manufacturers in analyzing and applying new technologies for improving their industrial productivity. In 1985 the Foundation began to establish a statewide Industrial Innovation Extension Service, designed to bring new technology information and problem solving assistance to firms through one-to-one consultation by field representatives. New York's recently announced "Recovery to Resurgence" economic strategy, formulated by Vincent Tese, the state's Director of Economic Development, highlights the need for and strengthens initiatives geared to shoring up the manufacturing base of our economy.

In carrying out its new mission through creation and implementation of these programs, the Foundation has grown in budgetary terms to a $15 million annual operation, which is now staffed by fourteen employees.

III. New York's Small Business Innovation Research Promotion Program

A. Early SBIR Support

Beginning almost immediately after the 1982 enactment of the Small Business Innovation Development Act (P.L. 97-219), which was significantly advanced and supported by New York's congressional delegation, New York began a series of outreach program activities to inform our small technology-based firms of the unique SBIR funding opportunity. Efforts undertaken by the Foundation and the New York State Department of Commerce in 1982 and 1983 consisted of mailings to small business firms, conducting a series of state-wide workshops to inform companies in more detail of the new program, and offering technical and proposal writing assistance.

Of key importance in these early activities was the close cooperation and involvement of the university community. In particular, the newly designated Centers for Advanced Technology participated in the workshops, and offered expertise in proposal writing and relevant research.

B. New York's Initial Participation in the Federal SBIR Program

At the end of Fiscal Year 1983, the first year of the Federal SBIR Program, New York small business firms had been awarded 25 new Phase I project contracts totaling approximately $1.1 million. This "showing" placed New York ninth in the nation, far behind comparably developed states such as California (over 150 awards) and Massachusetts (over 100 awards). On a demographically compared basis, New York would have ranked 30th out of the fifty states in terms of actual SBIR-winning performance.

h the unique and budgetarily growing opportunity offered by SBIR to New York's small businesses becoming known, ideas for improving the level of participation in the Federal program began to appear. From the beginning, SBIR was seen as not only an excellent financial assistance mechanism for new and growing small firms, in itself a tremendous economic development tool which dovetailed with existing state programs, but also as a major research program. SBIR funds would accelerate the innovation process, develop new technologies, and add to our state's significant technology resources.

C. Legislative Enactment

As discussions on how to best capitalize on the SBIR opportunity continued, the importance of designing a complementary program grew. In addition to providing a financial assistance incentive, the need to "bridge the gap" between Phases I and II of the Federal program was becoming nationally important. This became a key concept of the New York SBIR Program.

During the 1983/1984 Legislative Session, concepts and operating characteristics for a state SBIR program were finalized, agreements reached on key elements, and legislation in the form of an amendment to the Foundation's Public Authorities Law was introduced in both the State Assembly and Senate. Co-sponsored by several legislators in each body on a bipartisan basis, the legislation was passed and signed into law as the "New York State Small Business Innovation Research Promotion Act" by Governor Cuomo on July 19, 1984. A first year appropriation of $500,000 was made to the Foundation for matching contract awards. A copy of this legislation is attached.

The "Legislative Intent" section of the statute best summarizes the reasons behind New York's SBIR Program:

> "The Legislature finds and declares that it is in the best interest of the state to increase participation by New York small businesses in the federal small business innovation research program and to assist New York small businesses in becoming SBIR Phase II grant recipients. Small technology-based firms are the source of approximately one-half of our nation's major innovations. By implementing a promotion and matching state program in this legislation, the state can encourage the formation, growth and development of small, innovative high technology companies in the state and contemporaneously stimulate high risk or advanced technology research and development by New York small businesses which potentially could lead to commercialization of new products and processes. Such a program which encourages existing high technology companies to remain and expand in New York creates expanded employment opportunities and assists in the growth and development of the economy of New York."

IV. Program Structure and Operation

The New York State SBIR Promotion Program essentially consists of two major components - publicity and matching contract awards.

A. Publicity

Under the new statute, the Foundation is required to conduct a formal program to inform small businesses of the Federal SBIR Program and the New York Program in order to increase the opportunity for New York firms to participate in the Federal program.

Building upon the earlier outreach efforts discussed above, the Foundation and the New York State Commerce Department's Division for Small Business increased the coverage and frequency of promotional workshops. In 1984 and 1985 ten such programs were conducted in all areas of the state, concentrating upon technology-intensive geographic areas with strong research university presences. These workshops included both plenary sessions providing general information on the existence and operation of the Federal and State SBIR programs, and specific "advanced level" training in SBIR proposal writing and submission strategies. To date these workshops have been attended by over 600 New York firms.

In addition, an extensive publicity campaign was begun with Governor Cuomo's issuance of a press release announcing the New York SBIR Program. Subsequent releases announced Federal awards received by New York firms and announcement of individual State matching contract awards. Newspapers and scientific journals were notified of New York's program, and several major articles were written.

This publicity component of New York's program is at least equally important to the matching contract awards, and is being conducted continually. The fast-moving world of new technology enterprises is difficult to reach, and new small businesses are constantly being formed. It is our experience that not only is an SBIR publicity program essential, but that it produces results. We suggest that other states interested in capitalizing on the SBIR opportunity seriously consider, at minimum, establishing a formal publicity or promotion program.

B. Matching Contract Awards

The New York State SBIR Promotion Act is unusually prescriptive in directing the Foundation to administer the matching contracts component of the program. The major features of the program are summarized below.

Eligibility

1) The firm must be a small business with 250 or fewer employees.

2) The firm must have received and successfully completed a Federal Agency SBIR Phase I Award, including acceptance of its final report.

3) The firm must have properly submitted a complete Phase II application.

4) The firm must submit copies of its Phase I Final Report and its Phase II proposal to the Foundation.

Certification

After filing the Phase II application, the firm may submit a research and cost proposal to the Foundation requesting funds matching its Phase I award up to but not exceeding $50,000. The proposal must be compatible with the Phase I research. The firm must certify that:

1) Its principal place of business is in New York State;

2) The state funds will be used for research to be conducted solely in New York;

3) No state funds may be expended for travel, equipment or facilities; and

4) Not more than one-third of the funds may be used to subcontract for research or other services.

Type of Contract

A "fixed price" grant-like contract type is used. Contracts are written for six months, with payments made at regular intervals, beginning with an advance of 25% of the contracted funds. The program is designed to finance the small firm on an advance payment basis, lessening the financial strain that is a major problem for new small businesses.

Copies of interim progress and final reports are sent to the Federal agency which awarded the Phase I project, and which is reviewing the firm's Phase II proposal. The contract terms also include a provision protecting any proprietary information developed by the firm.

V. Accomplishments to Date

The New York SBIR Promotion Program began at the end of Federal Fiscal Year 1984. New York's share of the FY 1984 Federal SBIR program went from 25 FY 1983 awards to 35 FY 1984 awards for approximately $1.6 million, still well below what was expected to be achieved. Several of the FY 1983 projects were successfully converted to Phase II awards, but the conversion rate was still well below the national average.

The State's program went into full operation in September 1984, with a Foundation-sponsored statewide conference of Regional Technology Development Organizations, State Legislators, commercial developers, venture capital firms, and other parties at interest. This conference "kicked off" the new program, generating publicity and broad interest. The workshop program described above began immediately thereafter.

Also at this time, the first eligible firms (NSF Phase I winners announced in January/February 1984) were notified, and tracking of their Phase I projects began. These firms completed their Phase I projects in the Fall of 1984, and applied for and received the Foundation's first matching fund awards effective December 31, 1984.

To date the Foundation has made 35 matching contract awards totalling $1,479,876 to New York small business companies. The original $500,000 SBIR appropriation made in 1984 was increased to $2.25 million in 1985, maintaining the 100% matching capability for all eligible firms. At present 105 New York SBIR Phase I winners are eligible for participation in the state program. Their Phase I awards total over $5 million.

With respect to the much larger Federal SBIR Phase II awards, over 60% of New York small businesses assisted under the state program have converted their Phase I awards to Phase II awards totalling almost $8 million. This conversion rate is well above the national average.

As noted above, Federal Fiscal Year 1985 was the first year in which the impact of New York's SBIR Program could be measured. With the recent announcement by the National Science Foundation of its Fiscal Year 1985 Phase I awards, New York Firms have garnered 62 new awards, a 75% increase in the award rate from Fiscal Year 1984. The table below gives a year-by-year award comparison:

	FY 1983	FY 1984	FY 1985
1. Number of Phase I awards to New York firms	25	35	62
2. Dollar Value	$1.1 million	$1.6 million	$3.1 million (est)

In addition to the dramatic increase in awards won by New York firms, the state program has also served an industrial recruitment purpose. Three small businesses with a total of five SBIR Phase I awards among them have relocated to New York to take advantage of the State's SBIR funding opportunity. This aspect of the program has direct economic development impact, bringing new high technology industry and new jobs into the state.

VII. Summary

The New York State SBIR promotion program was the first in the nation, and remains as a unique small business financing and economic development mechanism. The State of New Jersey has established a somewhat similar program, and other states, e.g., Pennsylvania, have put in place strong SBIR promotional and technical assistance operations.

The Federal SBIR program is one of the strongest and most effective small business assistance, innovation-producing, economic development programs legislated. It provides entrepreneurs with vital "seed capital" at a firm's earliest and highest-risk state. It allows a company to be established, exploring and commercializing an idea which may lead to a technological breakthrough. It represents "no strings" capital to the entrepreneur, financing research and development without having to give up equity in the firm or take on debt. Response and support for the SBIR Program from the business community have been excellent.

In the future, the New York SBIR Program, as legislated, will continue until termination of the Federal program. Subject to the availability of funds, the 100% matching ratio will be maintained. SBIR winners will be further assisted after completion of Phase II work by networking them with sources of investment capital, including the Foundation's Corporation for Innovation Development. This activity is already underway, as we have assisted several SBIR firms to obtain Phase III SBIR financial commitments to strengthen their Phase II proposals.

The Executive and Legislative Branches of New York's Government recognize the importance of new technologies and industrial innovation to economic development. The Federal SBIR program has now proven itself to be an excellent vehicle to achieve these purposes.

STATE OF NEW YORK

S. 8997--B A. 11306--B

Ch# 448

SENATE—ASSEMBLY

April 11, 1984

IN SENATE -- Introduced by Sens. LAVALLE, DALY, DONOVAN, FARLEY, FLOSS, FLYNN, GOODHUE, JOHNSON, KEHOE, KNORR, LACK, LOMBARDI, PADAVAN, PISANI, ROLISON, SCHERMERHORN, TRUNZO, TULLY, VOLKER -- read twice and ordered printed, and when printed to be committed to the Committee on Corporations, Authorities and Commissions -- committee discharged, bill amended, ordered reprinted as amended and recommitted to said committee -- committee discharged, bill amended, ordered reprinted as amended and recommitted to said committee

IN ASSEMBLY -- Introduced by COMMITTEE ON RULES -- (at request of M. of A. Ruggiero, Ferris, Fink, Schimminger, Robac -- read once and referred to the Committee on Corporations, Authorities and Commissions -- committee discharged, bill amended, ordered reprinted as amended and recommitted to said committee -- reported and referred to the Committee on Ways and Means -- committee discharged, bill amended, ordered reprinted as amended and recommitted to said committee

AN ACT to amend the public authorities law, in relation to providing for a small business innovation research promotion program to be administered under the direction of the New York state science and technology foundation, providing for additional powers and duties of such foundation and changing the day upon which the annual report of such foundation must be made

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

Section 1. Legislative intent. The legislature finds and declares that it is in the best interest of the state to increase participation by New York small businesses in the federal small business innovation research program and to assist New York small businesses in becoming SBIR Phase II grant recipients. Small technology-based firms are the source of approximately one-half of our nation's major innovations. By implementing a promotion and matching state program in this legislation, the state can encourage the formation, growth and development of small, innovative high technology companies in the state and contemporaneously stimulate high risk or advanced technology research and development by

EXPLANATION--Matter in italics (underscored) is new; matter in brackets [ ] is old law to be omitted.

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New York small businesses which potentially could lead to commercialization of new products and processes. Such a program which encourages existing high technology companies to remain and expand in New York creates expanded employment opportunities, and assists in the growth and development of the economy of New York. The legislature therefore enacts the provisions of this act and establishes the New York state small business innovation research promotion program.

§ 2. This act shall be known and may be cited as the "New York state small business innovation research promotion act".

§ 3. The public authorities law is amended by adding a new section thirty-one hundred two-b to read as follows:

§ 3102-b. Small business innovation research program. 1. As used in this section, the following terms shall have the following meanings:

(a) "Small business innovation research program" or "SBIR" means that program, enacted pursuant to the small business innovation development act of 1982 (P.L. 97-219), which provides funds to small businesses to conduct innovative research having commercial application.

(b) "Small business" means a corporation, partnership, sole proprietorship or individual, operating a business for profit, with two hundred fifty employees or less, including employees employed in any subsidiary or affiliated corporation which otherwise meets the requirements of the federal small business innovation research program.

2. (a) Within thirty days of the public announcement of the small business innovation research program Phase I award winners by the appropriate federal agency, the foundation shall contact all Phase I award recipients, whose principal place of business is located in this state, provide them with information concerning the program authorized pursuant to this section and advise them of the requirements relating thereto. Any such recipient, at least thirty days prior to the completion of its SBIR Phase I grant period, may, at its discretion, submit to the foundation a notice of its desire to secure research funding pursuant to the provisions of this section, along with a copy of its original federal SBIR proposal and such additional information the foundation may require to assist it in determining the eligibility of such recipient for this program.

(b) In addition to receipt of an SBIR award, any small business shall meet the following criteria:

i. Such small business' principal place of business shall be located in this state;

ii. Such small business shall certify that the research to be conducted will be performed solely in this state;

iii. No moneys shall be expended for travel, equipment or facilities; and

iv. Not more than one-third of any moneys awarded to a firm by the foundation may be used to contract for research or other related services.

(c) Upon a finding by the science and technology foundation that a Phase I award recipient whose principal place of business in in New York has satisfactorily met all the requirements of this section, the foundation shall notify such small business that it will award the firm a research contract. Such contract shall be compatible with and a continuation of the research to be performed under the SBIR contract awarded by the federal agency involved and shall not exceed the amount of the SBIR award or fifty thousand dollars whichever is less, provided, however, that the total amount of all contracts shall not exceed the amount appropriated for this purpose.

3. The foundation shall not disburse any moneys to a small business until

(a) such small business has completed its SBIR Phase I research,

(b) its final Phase I report with respect thereto has been accepted by the federal agency involved,

(c) its Phase II research proposal has been properly submitted to the federal agency involved, and

(d) it has submitted copies of its final Phase I report and its Phase II proposal to the foundation.

4. Consistent with federal SBIR procedures, the foundation shall not disclose proprietary information when so requested by participants in this program.

5. The foundation shall annually submit a report to the governor, the temporary president of the senate and the speaker of the assembly detailing the results of the program, including but not limited to the number of New York small businesses applying for SBIR awards, the number receiving Phase I awards, the number receiving Phase II awards, any products or processes developed as a result of the SBIR research involved, any patents applied for or licenses granted based on the SBIR research involved and an abstract of the SBIR Phase I and II work performed by New York firms and any other information pertinent in evaluating the program.

6. The foundation shall conduct a program to inform small businesses of the federal SBIR program and this New York state program in order to insure that all firms have the opportunity to participate in these programs.

7. The foundation shall facilitate and promote the establishment of joint small business-university technology councils at the centers for advanced technology and other universities within the state whereby small firms and university experts can facilitate the transfer of technology and work together on research projects related to the SBIR program or other research projects of mutual interest.

8. The provisions of this section shall be effective if, and as long as federal financial participation is available therefor pursuant to the small business innovation development act of 1982.

§ 4. Section thirty-one hundred two of such law is amended by adding a new subdivision three-a to read as follows:

3-a. To establish and keep current, a roster of New York based small high technology firms.

§ 5. Section thirty-one hundred eight of such law, as added by chapter one hundred ninety-seven of the laws of nineteen hundred eighty-one, is amended to read as follows:

§ 3108. Annual report. The corporation shall make an annual report to the governor and the legislature not later than [March] July first of each year.

§ 6. This act shall take effect immediately.

Senator **Rudman** [assuming the chair]. Thank you very much, Mr. Barker.

I want to just briefly apologize to the panels for not having been here for the beginning of the hearing. Obviously, I have more than a passing interest in this legislation, and I have been conducting hearings and will continue to conduct hearings on its effectiveness.

Unfortunately, I had to attend a meeting with the President this morning. It was called yesterday, and the President, like most of us, has a hard time keeping his schedule on time, also, so we ran late. But I will certainly review all of your testimony, those of you that I did not hear personally.

Mr. Blackman.

STATEMENT OF A. WADE BLACKMAN, GENERAL PARTNER, AMERICAN RESEARCH & DEVELOPMENT, INC., BOSTON, MA

Mr. **Blackman**. Thank you, Mr. Chairman.

My name is Wade Blackman. I am a general partner of American Research & Development. We are a private venture capital firm located in Boston. We were founded in 1946, and I think we are generally considered to be the oldest venture capital firm in the Nation.

In my testimony, I try to cover three things, and in the interest of saving a little time, I will briefly summarize most of it and move on.

Senator **Rudman**. We will make sure your entire statement appears in the record, and a summary would be most appreciated.

Mr. **Blackman**. All right.

The first point I try to make is related to the influence of technical innovation on the economy. To summarize that point, technology has a huge effect on the economy if, and only if, that technology is embodied in a successfully commercialized product.

Next, I discuss the current status of technological innovation in the United States. I think everybody recognizes that our position vis-a-vis the rest of the world is deteriorating rapidly and probably, without some changes in our policy, will continue to do so.

My final area of discussion is to comment on the potential of venture capital and SBIR investment for doing something to improve the rate of technological innovation in our country. I would like to spend the rest of my time on that issue.

The U.S. venture capital industry is made up of independent private investors to the extent of about 72 percent of all the investment. Corporate investors are about 18 percent and SBIC's are about 10 percent.

In 1984, new capital commitments of $4.2 billion were made, and at year-end of 1984, the industry's total dollars of capital under management reached $16.3 billion. Disbursements from the venture capital industry are small relative to the annual R&D expenditures which in 1985 were greater than $100 billion.

The size of the entire venture capital industry's annual disbursements is the same order and magnitude as IBM's annual R&D budget. Although relatively small in magnitude, the venture capital industry has a disproportionately large effect on the economy, and that is mainly due to the fact that venture capital investment is concentrated in small firms.

Studies at the National Science Foundation and at MIT have indicated that small firms with less than 100 employees are about six times more effective in creating technological innovations than are large Fortune 500 firms. Eighty-seven percent of all new jobs created during the 1969-76 period were in small firms with 500 employees or less.

Typically, venture capital firms do not like to invest in a project until after it has completed the prototype development stage. If the project is an innovation based on an incremental improvement in technology, for each dollar spent on R&D, an additional $7 will usually be required to complete the prototype, and about $7 more will be required to produce the first commercial unit.

If the time to complete the R&D was 1 year, it will typically take another 3 years to complete the first commercial unit and another 2 years to produce profits. Although technology is an essential input, most ventures rarely fail because of technology issues. They are much more likely to fail because of either a lack of capital, inadequate management, or because of market factors.

The Small Business Innovation Development Act has had a significant impact on small high technology firms. It has proven very effective as a feeder for venture capital investment. A recent survey has indicated that about 65 percent of firms submitting phase II proposals seek follow-on phase III funding commitments. Some 21 percent of these commitments are generally made from venture capital firms.

The SBIR Program also provides an effective means for small firms to access Federal R&D funds. Currently, almost 3 percent of government R&D goes to firms with less than 500 employees. Through 1987 some $1.3 billion in awards will have been distributed. Although most of the Federal R&D funds still flow to big firms and big universities, the SBIR Program has provided the small firm access to funds which are very difficult to get from other sources. It has also provided the Government access to the most creative and innovative sector of industry.

It would therefore appear that the benefits of this program far outweigh costs and that the country is well served by spending a share of its R&D budget with small firms.

Many of the changes and recommendations have already been made by the other speakers. I would like to throw out one more for consideration. I think we made the point earlier that commercialization is required to produce social and private returns from the R&D process, and we also made the point that innovations rarely fail because of technology issues. Technology is a necessary input but not a sufficient input, and most ventures fail because of lack of capital or poor management or marketing problems.

Based on those two assertions, I would like to suggest that selection criteria for SBIR grants be broadened to give greater consideration to management and marketing issues in the early phases of proposed ventures. I think it might be useful to consider the possibility of allowing market research expenses to be part of the earlier grants, if not in phase I, hopefully in phase II. I think this would go a long way to attract venture capital into the situations for the phase III money, because the venture capitalist is looking for the things that make ventures fail and typically market and management are high on the top of his list.

Thank you very much, sir.

[The prepared statement of Mr. Blackman follows:]

Statement of

A. Wade Blackman
General Partner
American Research & Development Inc.

Before the

Subcommittee on Innovation and Technology

Committee on Small Business

U.S. Senate

March 11, 1986

Mr. Chairman and Members of the Subcommittee:

I am A. Wade Blackman, a General Partner of American Research & Development Inc., a venture capital firm located in Boston. We were founded in 1946 and are generally considered to be the oldest venture capital firm in the nation.

I appreciate this opportunity to appear before this Committee and to present a view on the SBIR program from the perspective of a venture capitalist. To do this, I would like first to briefly discuss the influence of technological innovation on the U.S. economy, next, to discuss the current status of technological innovation in the U.S., and, finally, to comment on the potential of venture capital and SBIR investment for improving the rate of technological innovation.

The Influence of Technological Innovation on the U.S. Economy

Around 150 years ago at the time of the industrial revolution, Western society first learned how to achieve an increase in wealth by peaceful means. This knowledge had been denied to all earlier societies which prior to this time had relied on war, plunder, expropriation, taxation, etc. as their primary means for increasing wealth. The key to this achievement was obtaining a productivity level which allowed the output from an expenditure of capital, labor and/or other input factors to increase at a rate which was more than proportional to the input. Productivity improvements have been the means by which a steady increase in wealth and a rising standard of living has been maintained. Obtaining productivity improvements has traditionally been the central focus of two groups: the engineers and the economists, and our modern industrial society has been made possible primarily through their work.

The engineer has been concerned with the problem of finding the best way of maximizing output from physical systems; the economist has sought to find the most appropriate mix of men and machines to obtain a given output; and the concept of efficiency has served to unify the efforts of both groups.

Historically, the U.S. has led the rest of the world in achieving high productivity levels. In recent years, however, our pre-eminence has been increasingly under challenge. Formerly, the U.S. produced about one-half of the world's goods. We now produce less than one-third.

Labor productivity, or output per man hour, depends on the amount of capital invested per worker and how effective that capital is in enhancing worker output. Increases in the effectiveness of the capital investment depends on technological innovation. Thus, a strong linkage exists between our rate of technological innovation and our rate of economic growth. The key phrase here is innovation, by which I mean the successful commercialization of research and development (R&D). The bulk of social returns from R&D expenditures results from the embodiment of the new technology in new products and/or services which create new jobs and increase income and tax revenues. The R&D process produces very small returns unless the process results in a commercially successful innovation.[1] For R&D to be productive, it is not enough to produce an innovation which is a technical success, it must be a commercial success as well.

The Status of Technological Innovation in the U.S.

The United States, with about 5 percent of the world's population, currently produces about half of the world's technology. However, over the past 10 years, the share of the world's technology produced in the U.S. has decreased significantly. The amount of the high technology exports from the U.S. has also decreased. In 1962, the U.S. share of industrialized country high-technology exports was about 30 percent; in 1980 the U.S. share had fallen to about 24 percent. Over this same period Japan's share grew from about 4 percent to about 12 percent. If current trends persist, market shares will be about equal in 1990. Between 1964 and 1979, R&D expenditures as a percentage of gross domestic product fell in the U.S. from 3.1 to 2.4 percent, while in Japan they grew from 1.5 to 2.0 percent.

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1. Studies by Mansfield and others have indicated that the public returns from R&D may typically be of the order of 43 percent and the private returns may typically be of the order of 28 percent if the research is embodied in successful product innovations.

One way of assessing a country's position in technological development is through a composite index that shows the combined effects of trade in high tech products, foreign direct investment in the technology sector, foreign earnings from patents and licenses, and foreign technical assistance. Comparisons of the U.S., Japan, Germany, France and the U.K. on the basis of this index between 1974 and 1983 shows that the current U.S. position is about three-fourths of what it was in 1974. Japan, however, has increased its position since 1974 by a factor of about 2.7.

Much of our decline in technological innovation can be traced to what Business Week has described as the "hollow corporation" and to what Robert Reich of Harvard has termed "paper entrepreneurialism" whereby managers of firms attempt to generate profits through manipulation of rules and numbers rather than through investing in new assets which improve productivity. Indicative of this trend is the increase in the number of lawyers relative to the number of engineers. In the 1971 - 1981 decade, the increase in the number of lawyers in the U.S. was about four times the increase in the number of engineers. America now has about one lawyer for every 400 citizens. In Japan, only about one in 10,000 is a lawyer while one out of 25 is trained as an engineer or scientist. The Japanese tend to view business problems as engineering problems amenable to technical solutions. In the U.S., these same problems are likely to be viewed as legal or financial problems to be solved by manipulation of rules or numbers.

Having made the point that the U.S. position as a world leader in technology is increasingly being challenged, I would like to discuss next what venture capital and SBIR investments can do to improve our position.

The Effect of Venture Capital and SBIR Investment on the Rate of Technological Innovation

The U.S. venture capital industry is made up of independent private investors (72%), corporate investors (18%) and SBIC's (10%). In 1984 new capital commitments of $4.2 billion were made, and at year-end the industry's total dollars of capital under management reached $16.3 billion. About 34% of capital disbursements went to firms in seed, start-up or other early stages of development; 54% went to firms needing second or third stage expansion financing.

Disbursements from the venture capital industry are small relative to annual R&D expenditures which in 1985 were greater than $100 billion. The size of the entire venture capital industry annual disbursements is the same order as IBM's annual R&D budget. Although relatively small in magnitude, the venture capital industry has a disproportionately large effect on the economy, because venture capital investment is concentrated in small firms. Studies at MIT have indicated that small firms with less than 100 employees are about six times more effective in creating technological innovations than are large (Fortune 500) firms. Eighty-seven percent of all net new jobs created during the 1969-1976 period were in small firms with 500 employees or less.

Typically, venture capital firms do not like to invest in a project until after it has completed the prototype development stage. If the project is an innovation based on an incremental improvement in technology, for each dollar spent on R&D, an additional seven dollars will usually be required to complete the prototype and about seven dollars more will be required to produce the first commercial unit. If the time to complete the R&D was one year, it will typically take another three years to complete the first commercial unit and another two years to produce profits. Although technology is an essential input, new ventures rarely fail because of technology issues; they are most likely to fail because of a lack of capital, inadequate management or because of market factors.

The Small Business Innovation Development Act (P.L. 97-219) was signed into law in 1982. This legislation was modeled after the Small Business Innovation Research (SBIR) program initiated at the National Science Foundation in 1977 and serves to extend its effectiveness. The extended SBIR program has had a significant impact on small, high-technology firms. It has proven very effective as a feeder for venture capital investment. A recent survey has indicated that about 65 percent of firms submitting Phase II proposals seek follow-on Phase III funding commitments. Some 21 percent of these commitments are from venture capital firms.

The SBIR program also provides an effective means for small firms to access Federal R&D funds. Currently, almost three percent of government R&D goes to firms with less than 500 employees. Through 1987 some $1.3 billion in awards will have been distributed. Although most of Federal R&D funds still flow to big firms and big universities, the SBIR program has provided the small firm access to funds which are very difficult to get from other sources. It has also provided the government access to the most creative and innovative sector of industry.

It would, therefore, appear that the benefits of this program far outweigh its costs and that the country is well-served by spending a share of its R&D budget with small firms.

Summary

I would like to summarize my remarks with three concluding points.

- The U.S. economy benefits from the commercialization of technological innovations.
- Technological innovation in the U.S. is not as active as it once was and is increasingly subject to foreign competition.
- The SBIR program appears to have a favorable effect on the rate of innovation and is worthy of continued support.

AMERICAN RESEARCH & DEVELOPMENT INC.
STAFF BIOGRAPHY

A. WADE BLACKMAN, JR. - Vice President

Wade Blackman has over 25 years of senior engineering, financial and operating management experience related to high technology ventures. The early part of his career was spent with United Technologies Research Center, after which he served in the U.S. Government on the staff of the Science Advisor to President Ford, and as a Deputy Assistant Administrator in the Energy Research and Development Administration. He then became CEO of the Binational Industrial Research and Development Foundation, and prior to joining ARD was associated with Stone and Webster.

Mr. Blackman has 13 patents, 50 publications, and is a recipient of the American Institute of Aeronautics and Astronautics Goddard Award. A registered professional engineer and a member of Tau Beta Pi, he holds graduate degrees in engineering and in management from MIT.

Senator RUDMAN. Thank you very much, Mr. Blackman, Mr. Barker, and Mr Andrade. We appreciate your being here this morning.

If there are other questions as we look at your testimony, we will communicate them to you, and I am going to try to move the hearing along so as not to keep people beyond their normal appointments.

Thank you very much.

The next panel will be Mr. Shane, Ms. Frazier, and Dr. Young.

Mr. Shane is the Assistant Administrator, Office of Innovation, Research and Technology, SBA, in Washington. Mr. Shane, your entire statement will be placed in the record of this hearing. We would like you to summarize if you could.

STATEMENT OF RICHARD J. SHANE, ASSISTANT ADMINISTRATOR, OFFICE OF INNOVATION, RESEARCH & TECHNOLOGY, SMALL BUSINESS ADMINISTRATION

Mr. SHANE. Thank you, Mr. Chairman.

It is indeed a pleasure to appear before you today to present my thoughts concerning the Small Business Administration's report to Congress entitled "Second Year Results under the Small Business Innovation Development Act of 1982."

I would like to take a moment to express the Small Business Administration's, and my personal, appreciation to Senator Rudman and Chairman Weicker for your leadership in steering the authorizing legislation through the Senate and for your continuing interest and support of the highly successful Small Business Innovation Development Act of 1982.

At the outset, I would like to state that the Small Business Innovation Research Program is in its fourth year of performance. I am pleased to report to you today that, on balance, the first 2 years of the program have received high marks. This was illustrated by the General Accounting Office's report to the Congress entitled "Implementing the Small Business Innovation Development Act—the First Two Years," dated October 25, 1985. Early fiscal year 1985 data indicates continued maturity and improvement in the program.

I would also like to point out that the President's fiscal year 1987 budget submission provides for the transfer of the Office of Innovation Research and Technology to the Department of Commerce. This would allow for an uninterrupted administration of the Small Business Innovation Development Act. No programmatic changes are anticipated as a result of this change.

SBA's annual reports to Congress have delineated fiscal years 1983 and 1984—it is anticipated that 1985 will be presented in an annual report on or about May of 1986. Major areas of interest are the subjects of agency extramural SBIR authorizations, technical topics, proposals received, awards made, and the commercialization matching system.

During fiscal year 1984 five participating agencies obligated $2,377,000 over and above their legislated extramural SBIR authorizations. The decision to increase obligations was based in the technical consensus to acquire additional innovations. Five agencies had obligations in a total deficit of $10,101,000. The Department of Defense represented $9,054,000 of this amount.

This amount represents DOD's position that their category 6.6 funds are not to be considered as research and development funds for the purposes of the SBIR Program. This issue was reviewed by GAO in their report of October 25, 1985. It has now become GAO case No. B-209790 at the request of the House Small Business Committee.

The second largest amount represents $859,000 of the Department of Transportation. This had to do with a differential problem which has been resolved. This leaves a deficit of $188,000 which amount was resolved with the agencies for fiscal year 1985 SBIR authorizations.

During fiscal year 1984, there was a continuation of phase I awards and the start of phase II awards. SBIR Program obligations increased from $45 million in fiscal year 1983 to $111.5 million in fiscal year 1984. The cumulative awards from fiscal years 1983 and 1984 were 1,790 phase I awards to 1,090 small businesses in 47 States and the District of Columbia.

Statistically, 87.4 percent of the small businesses received two or less awards, and 96.6 of the small businesses received five or less awards. Phase I multiple award winners were in 37 States and the District of Columbia.

In 1984, 357 phase II awards were made to 286 small businesses in 40 States and the District of Columbia. Two or less awards were made to 94 of the small business firms. Three or less awards were received by 99 percent of the awardees. Phase II multiple awards were made in 18 States and the District of Columbia.

I think it is interesting to note that in fiscal year 1984, 78 percent of the phase I awardees had not received a phase I award in fiscal year 1983. Early fiscal year 1985 data indicates that approximately 63 percent of the phase I awardees had not received fiscal year 1983 or 1984 awards.

The conclusion that can be drawn from this data is that there is an abundance of innovative ideas from a wide segment of small businesses, and the SBIR Program is indeed successful.

Under the Small Business Administration's audit and review authority, we continue to review agency solicitation technical topics. The premise of our review is to determine if the topics are conducive to commercialization. This topical commercialization process is achieved in two modes. Some agencies exist to provide research and development to further social needs and other agencies must fulfill research and development to further specific missions.

The SBIR Program purposes are met in the latter case by innovations which can serve dual markets. The SBA has observed numerous examples of this type of SBIR innovations. The SBA breaks the agency topics into three categories: specific product identified, problem identified, and research area identified.

In the vast majority of cases, agency technical topics provide small businesses with the necessary latitude to develop innovative concepts which can fulfill the needs of the agencies and commercialization potential.

In order to meet the legislated purpose of product commercialization, the Small Business Administration developed a computerized commercialization matching system for SBIR awardees. In basic terms, the CMS is a system which can link SBIR awardees with potential sources of capitalization, primarily venture capitalists and large businesses.

SBIR awardees are provided a list of commercial technology areas and select those which best fit their innovation. A computer search identifies potential sources of capital that indicated an interest in the same industry area. SBIR awardees are sent information on each source including a contact person, address, phone number, and the industry areas of interest.

Capitalization sources select from a list of technology areas to identify their investment interests. They are matched by computer search to SBIR projects categorized with the same technology areas. For each match, the potential source of capital is sent the technical abstract of the SBIR awardee project accompanied by the company name, address, and, if available, a contact person and phone number.

To aid in identifying SBIR awardees for potential sources of capital, CMS also has a technical keyword search capability. The current CMS data base has 2,000 SBIR awardees, 260 large companies, and 260 venture capital firms. Approximately 350 computer runs have been made to date.

Mr. Chairman, I would like to close by stating our pleasure with the results of the Small Business Innovation Development Act of 1982, and I would be more than happy to answer any of your questions.

[The prepared statement of Mr. Shane follows:]

SBA
U.S. Small Business Administration
Washington, DC 20416

STATEMENT OF
RICHARD J. SHANE, ASSISTANT ADMINISTRATOR
OFFICE OF INNOVATION, RESEARCH & TECHNOLOGY
SMALL BUSINESS ADMINISTRATION
BEFORE THE
SUBCOMMITTEE ON INNOVATION AND TECHNOLOGY
SENATE SMALL BUSINESS COMMITTEE

MARCH 11, 1986

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

IT IS INDEED A PLEASURE TO APPEAR BEFORE YOU TODAY TO PRESENT MY THOUGHTS CONCERNING THE SMALL BUSINESS ADMINISTRATION'S REPORT TO CONGRESS ENTITLED "SECOND YEAR RESULTS UNDER THE SMALL BUSINESS INNOVATION DEVELOPMENT ACT OF 1982." I WILL BE ASSISTED TODAY BY MR. JOHN SWEENEY AND MR. GEORGE MORNING.

I WOULD LIKE TO TAKE A MOMENT TO EXPRESS THE SMALL BUSINESS ADMINISTRATION'S, AND MY PERSONAL, APPRECIATION TO SENATOR RUDMAN AND CHAIRMAN WEICKER FOR YOUR LEADERSHIP IN STEERING THE AUTHORIZING LEGISLATION THROUGH THE SENATE, AND FOR YOUR CONTINUING INTEREST AND SUPPORT OF THE HIGHLY SUCCESSFUL SMALL BUSINESS INNOVATION DEVELOPMENT ACT OF 1982.

At the outset I would like to state that the Small Business Innovation Research program is in its fourth year of performance. I am pleased to report to you today that, on balance, the first two years of the program has received high marks. This was illustrated by the General Accounting Office's Report to The Congress entitled "Implementing the Small Business Innovation Development Act-- the First 2 years." dated October 25, 1985. Early fiscal year 1935 data indicates continued maturity and improvement.

Mr. Chairman, with your permission, before expressing my views of the specifics of the report, I would like to briefly highlight the history and accomplishments of the Small Business Innovation Development act.

The Small Business Innovation Development Act's Two Primary Programs

Public Law 97-219 set into being two separate and distinct programs to be implemented during fiscal year 1983. The primary program is the Small Business Innovation Research (SBIR) program and the secondary program is the Research and Research and Development Acquisition Goaling Program.

Under the SBIR program each agency with an extramural budget for Research or Research and Development in excess of $100 million for fiscal year 1982, or any fiscal year thereafter, was directed to establish an SBIR program. Program funding is from the participating agency's current extramural funds and will reach a maximum of 1.25% for civilian agencies within four years and for the Department of Defense within five years from program inception.

The current participating SBIR agencies are: Department of Agriculture, Department of Commerce, Department of Defense, Department of Education, Department of Energy, Department of Health and Human Services, Department of Interior, Department of Transportation, Environmental Protection Agency, National Aeronautics and Space Administration, National Science Foundation and the Nuclear Regulatory Commission.

The law directed that the program be a competitive three phase process. Phase I will determine as far as possible the scientific and technical merit and feasibility of ideas. Under Phase II the results of Phase I projects are evaluated and those found to have the most potential will be continued to further develop the proposed ideas for up to two additional years.

PHASE III IS THE KEYSTONE OF THE PROGRAM AND BRINGS INTO PLAY PRIVATE SECTOR INVESTMENT AND SUPPORT TO BRING THE INNOVATION INTO THE MARKETPLACE. IF A FEDERAL AGENCY HAS CONTINUED INTEREST AND NEED IN THE INNOVATION, ACQUISITION MAY PROCEED WITH NON-SBIR FUNDS.

THE RESEARCH AND RESEARCH AND DEVELOPMENT (R&R&D) GOALING PROGRAM IS THE SECOND PROGRAM AND IT REQUIRES AGENCIES WITH AN R&R&D TOTAL BUDGET IN EXCESS OF $20 MILLION FOR ANY FISCAL YEAR TO ESTABLISH SMALL BUSINESS GOALS FOR R&R&D FUNDING AGREEMENTS. THE GOAL TO BE SET ANNUALLY CANNOT BE LESS THAN AN AGENCY'S ACHIEVEMENT DURING THE PREVIOUS FISCAL YEAR. IN ADDITION TO THE PREVIOUSLY STATED TWELVE SBIR AGENCIES FIVE ADDITIONAL AGENCIES ARE INCLUDED. THEY ARE: DEPARTMENT OF JUSTICE, AGENCY FOR INTERNATIONAL DEVELOPMENT, SMITHSONIAN INSTITUTE, TENNESSEE VALLEY AUTHORITY AND THE VETERANS ADMINISTRATION.

SBIR PROGRAM CHRONOLOGY

SINCE THE INCEPTION OF THE SBIR PROGRAM WE HAVE BEEN THROUGH TWENTY FIVE MAJOR MILESTONES. THE TIMELY AND SUCCESSFUL ACCOMPLISHMENT OF THESE EVENTS HAS BEEN THE KEY TO THE

ASCENDANCY OF THE PROGRAM. SOME OF THE MAJOR MILESTONES WERE THE DEVELOPMENT AND ISSUANCE OF THE SMALL BUSINESS ADMINISTRATION'S POLICY DIRECTIVE, THE PUBLICATION OF THE SBIR PRE-SOLICITATION ANNOUNCEMENT, THE DEVELOPMENT OF A SMALL BUSINESS HIGH TECHNOLOGY MAILING LIST, AWARD OF PHASE I AND II FUNDING AGREEMENTS, AND THE ISSUANCE OF TWO SMALL BUSINESS ADMINISTRATION ANNUAL REPORTS TO THE CONGRESS.

SUSTAINING SMALL BUSINESS HIGH TECHNOLOGY COMPANY INTEREST

IN ORDER TO CONTACT AND INFORM THE SMALL BUSINESS HIGH TECHNOLOGY COMMUNITY WE SET INTO BEING A VARIETY OF EFFORTS. THESE INCLUDE SBIR PROGRAM PAMPHLETS, PARTICIPATION AT SBIR SEMINARS AND CONFERENCES, AWARDEE NEWS RELEASES AND SBA PRE-SOLICITATION ANNOUNCEMENTS. THE PIVOTAL POINT FOR MOST OF THESE IS THE SBIR PROGRAM COMPUTERIZED MAILING LIST. CURRENTLY THE MAILING LIST EXCEEDS 38,500 NAMES AND ADDRESSES. SBA DEVELOPED THIS MAILING LIST BY COMPANIES BEING INFORMED OF THE SBIR PROGRAM AND THEN REQUESTING TO BE PLACED ON THE SBIR MAILING LIST. DURING THE LAST THREE YEARS APPROXIMATELY 250 REQUESTS PER WEEK HAVE BEEN RECEIVED BY THE SBA.

SBA ANNUAL REPORT

SBIR PROGRAM FY-84

SBA'S ANNUAL REPORTS TO CONGRESS HAVE DELINEATED FISCAL YEARS 1983 AND 1984. (FY 1985 DATA WILL BE PRESENTED IN AN ANNUAL REPORT ON OR ABOUT MAY OF 1986). MAJOR AREAS OF INTEREST ARE THE SUBJECTS OF AGENCY EXTRAMURAL SBIR AUTHORIZATIONS, TECHNICAL TOPICS, PROPOSALS RECEIVED, AWARDS MADE, AND THE COMMERCIALIZATION MATCHING SYSTEM.

AGENCY EXTRAMURAL SBIR AUTHORIZATION

DURING FISCAL YEAR 1984 FIVE PARTICIPATING AGENCIES OBLIGATED $2,377,000 OVER AND ABOVE THEIR LEGISLATED EXTRAMURAL SBIR AUTHORIZATIONS. THE DECISION TO INCREASE OBLIGATIONS WAS BASED IN THE TECHNICAL CONSENSUS TO ACQUIRE ADDITIONAL INNOVATIONS. FIVE AGENCIES HAD OBLIGATIONS IN A TOTAL DEFICIT OF $10,101,000. THE DEPARTMENT OF DEFENSE REPRESENTED $9,054,000 OF THIS AMOUNT. THIS AMOUNT REPRESENTS DOD'S POSITION THAT THEIR CATEGORY 6.6 FUNDS ARE NOT TO BE CONSIDERED AS RESEARCH AND DEVELOPMENT FUNDS FOR THE PURPOSES OF THE SBIR PROGRAM. (THIS ISSUE WAS REVIEWED BY GAO IN THEIR REPORT OF OCTOBER 25, 1985, AND HAS NOW BECOME GAO CASE NUMBER B 209790 AT THE REQUEST OF THE HOUSE SMALL BUSINESS COMMITTEE).

The second largest amount represents $859.000 of the Department of Transportation. This had to do with a differential problem which was resolved. This leaves a deficit of $138.000 which amount was resolved with the agencies for fiscal year 1985 SBIR authorizations.

FY 1984 SBIR Awardees

Fiscal year 1984 was a continuation of Phase I awards and the start of Phase II awards. SBIR program obligations increased from $45 million in FY 83 to $111.5 in FY 84. The cumulative awards from FY's 83 and 84 were 1.790 Phase I awards to 1.090 small businesses in 47 states and the District of Columbia. Statistically 87.4% of the small businesses received two or less awards; 96.5% of the small businesses received five or less awards. Phase I multiple award winners were in 37 states and the District of Columbia.

In FY 84, 557 Phase II awards were made to 286 small businesses in 40 states and the District of Columbia. Two or less awards were made to 94% of the small business firms. Three or less awards were received by 99% of the awardees. Phase II multiple awards were made in 13 states and the District of Columbia.

IN FY 84, 78% OF THE PHASE I AWARDEES HAD NOT RECEIVED A PHASE I AWARD IN FY 83. EARLY FY 85 DATA INDICATES THAT APPROXIMATELY 63% OF THE PHASE I AWARDEES HAD NOT RECEIVED FY 83 OR 84 AWARDS.

THE CONCLUSIONS DRAWN FROM THIS DATA IS THAT THERE IS AN ABUNDANCE OF INNOVATIVE IDEAS FROM A WIDE SEGMENT OF SMALL BUSINESSES AND THE SBIR IS INDEED, SUCCESSFUL.

SBIR TECHNICAL TOPICS

UNDER THE SMALL BUSINESS ADMINISTRATION AUDIT AND REVIEW AUTHORITY, WE CONTINUALLY REVIEW AGENCY SOLICITATION TECHNICAL TOPICS. THE PREMISE OF OUR REVIEW IS TO DETERMINE IF THE TOPICS ARE CONDUCIVE TO COMMERCIALIZATION. THIS TOPICAL COMMERCIALIZATION PROCESS IS ACHIEVED IN TWO MODES. SOME AGENCIES EXIST TO PROVIDE RESEARCH AND DEVELOPMENT TO FURTHER SOCIAL NEEDS AND OTHER AGENCIES MUST FULFILL RESEARCH AND DEVELOPMENT TO FURTHER SPECIFIC MISSIONS. THE SBIR PROGRAM PURPOSES ARE MET IN THE LATTER CASE BY INNOVATIONS WHICH CAN SERVE DUAL MARKETS. THE SBA HAS OBSERVED NUMEROUS EXAMPLES OF THIS TYPE OF SBIR INNOVATIONS. THE SBA BREAKS THE AGENCY TOPICS INTO THREE CATEGORIES, SPECIFIC PRODUCT IDENTIFIED, PROBLEM IDENTIFIED AND RESEARCH AREA IDENTIFIED.

IN THE VAST MAJORITY OF CASES AGENCY TECHNICAL TOPICS PROVIDE SMALL BUSINESSES WITH THE NECESSARY LATITUDE TO DEVELOP INNOVATIVE CONCEPTS WHICH CAN FULFILL THE NEEDS OF THE AGENCIES AND COMMERCIALIZATION POTENTIAL.

THE SBA COMMERCIALIZATION MATCHING SYSTEM

IN ORDER TO MEET THE LEGISLATED PURPOSE OF PRODUCT COMMERCIALIZATION, THE SMALL BUSINESS ADMINISTRATION DEVELOPED A COMPUTERIZED COMMERCIALIZATION MATCHING SYSTEM FOR SBIR AWARDEES. IN BASIC TERMS THE CMS IS A SYSTEM WHICH CAN LINK SBIR AWARDEES WITH POTENTIAL SOURCES OF CAPITALIZATION (VENTURE CAPITALISTS AND LARGE BUSINESSES).

SBIR AWARDEES ARE PROVIDED A LIST OF COMMERCIAL TECHNOLOGY AREAS AND SELECT THOSE WHICH BEST FIT THEIR INNOVATION. A COMPUTER SEARCH IDENTIFIES POTENTIAL SOURCES OF CAPITAL THAT INDICATED AN INTEREST IN THE SAME INDUSTRY AREA. SBIR AWARDEES ARE SENT INFORMATION ON EACH SOURCE INCLUDING A CONTACT PERSON, ADDRESS, PHONE NUMBER, AND THE INDUSTRY AREAS OF INTEREST.

CAPITALIZATION SOURCES SELECT FROM A LIST OF TECHNOLOGY AREAS TO IDENTIFY THEIR INVESTMENT INTERESTS. THEY ARE MATCHED BY COMPUTER SEARCH TO SBIR PROJECTS CATEGORIZED WITH THE SAME TECHNOLOGY AREAS. FOR EACH MATCH THE POTENTIAL SOURCE OF CAPITAL IS SENT THE TECHNICAL ABSTRACT OF THE SBIR AWARDEE PROJECT ACCOMPANIED BY THE COMPANY NAME, ADDRESS, AND IF AVAILABLE, A CONTACT PERSON AND PHONE NUMBER.

TO AID IN IDENTIFYING SBIR AWARDEES FOR POTENTIAL SOURCES OF CAPITAL, CMS ALSO HAS A TECHNICAL KEYWORD SEARCH CAPABILITY.

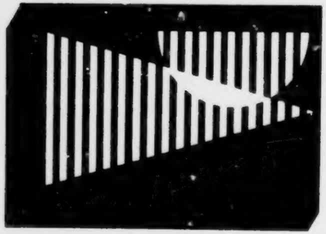
THE CURRENT CMS DATA BASE IS 2,000 SBIR AWARDEES, 260 LARGE COMPANIES AND 260 VENTURE CAPITAL FIRMS. APPROXIMATELY 350 COMPUTER RUNS HAVE BEEN MADE TO DATE.

MR. CHAIRMAN, I WOULD LIKE TO CLOSE BY STATING OUR PLEASURE WITH THE RESULTS OF THE SMALL BUSINESS INNOVATION DEVELOPMENT ACT.

MR. CHAIRMAN: THIS CONCLUDES MY PREPARED STATEMENT. WE WILL BE PLEASED TO ANSWER ANY QUESTIONS THE SUBCOMMITTEE MAY HAVE.

U.S. SMALL BUSINESS ADMINISTRATION

Office of Innovation, Research & Technology



SBIR Program

Public Law 97 - 219

U.S. SMALL BUSINESS ADMINISTRATION

Small Business Innovation Research Program

Program Chronology

- SBIDA PL 97-219 — 7/82
- Mailing List
SBIR Program Brochure — 8/82
- Program Policy Directive — 11/82
- First Agency Solicitation — 12/82
- First Pre-Solicitation Announcement — 1/83
- DoEd
First Phase I Awards — 7/83
- DOC
Policy Directive Revision — 8/83

- Second Year of SBIR — 10/83
- Awardee Publication — 11/83
- First Congressional Annual Report — 2/84
- Senate Hearing — 3/84
- First Phase II Awards — 4/84
- Awardee Publication — 6/84
- Publication on Proposal Preparation — 9/84

- Third Year of SBIR — 10/84
- Congressional Hearing — 4/85
- SBA Commercialization Matching System — 5/85
- Second Congressional Annual Report — 9/85
- Fourth Year of SBIR — 10/85
- General Accounting Office Report to Congress — 11/85
- Second Congressional Hearing — 11/85
- Second Senate Hearing — 3/86

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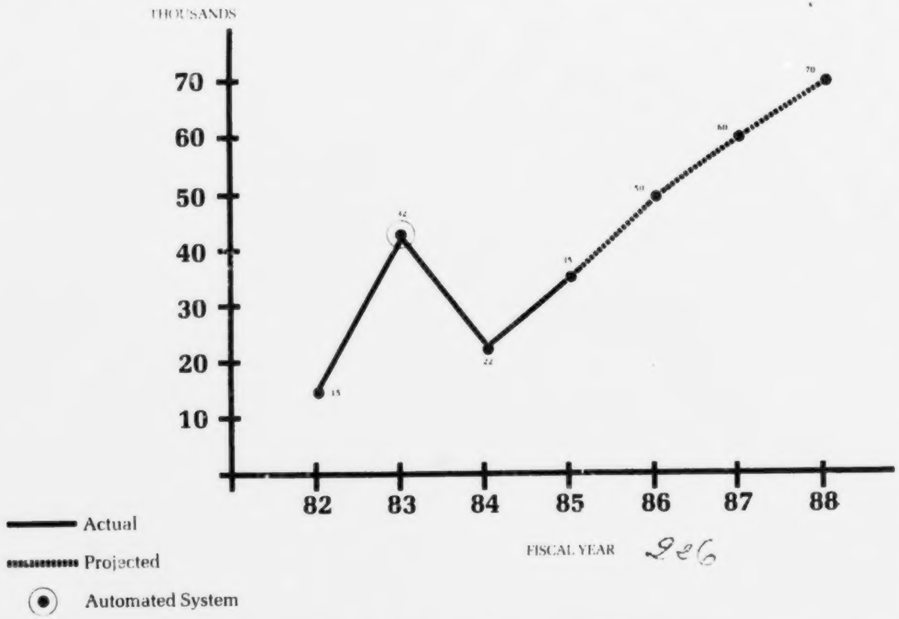
U.S. SMALL BUSINESS ADMINISTRATION

Office of Innovation, Research & Technology

SBIR Program

Mailing List



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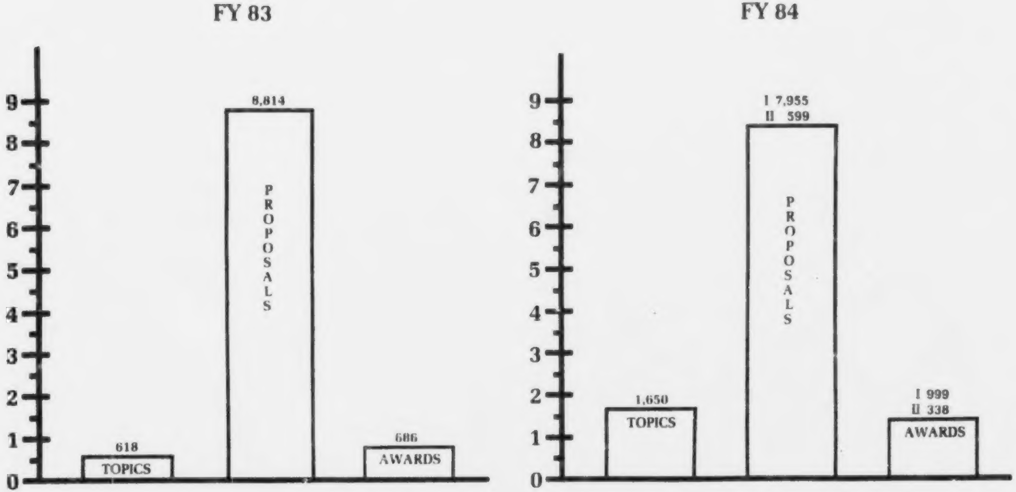
U.S. SMALL BUSINESS ADMINISTRATION

Office of Innovation, Research and Technology

SBIR Program

Acquisition Growth



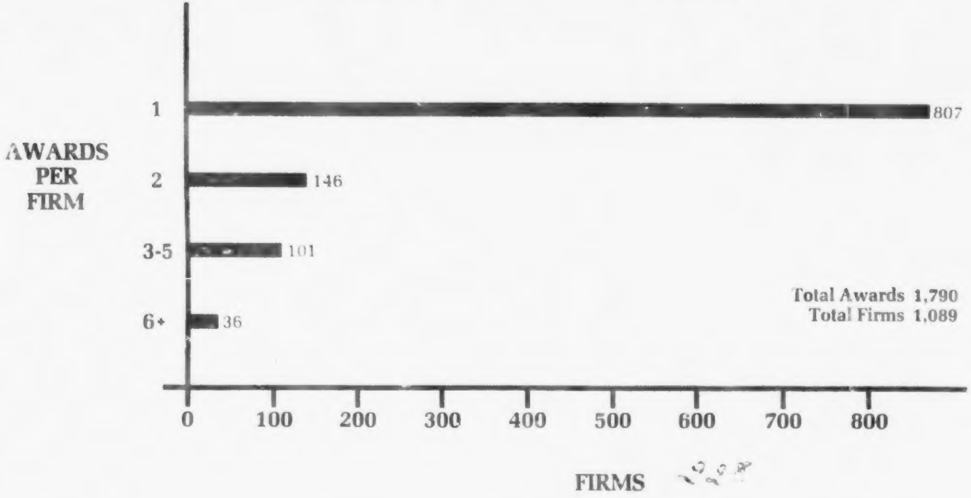
All Figures from Annual Reports to the Congress

U.S. SMALL BUSINESS ADMINISTRATION

Office of Innovation, Research and Technology

SBIR Multiple Awards Statistics

FY 83 and 84 Phase I



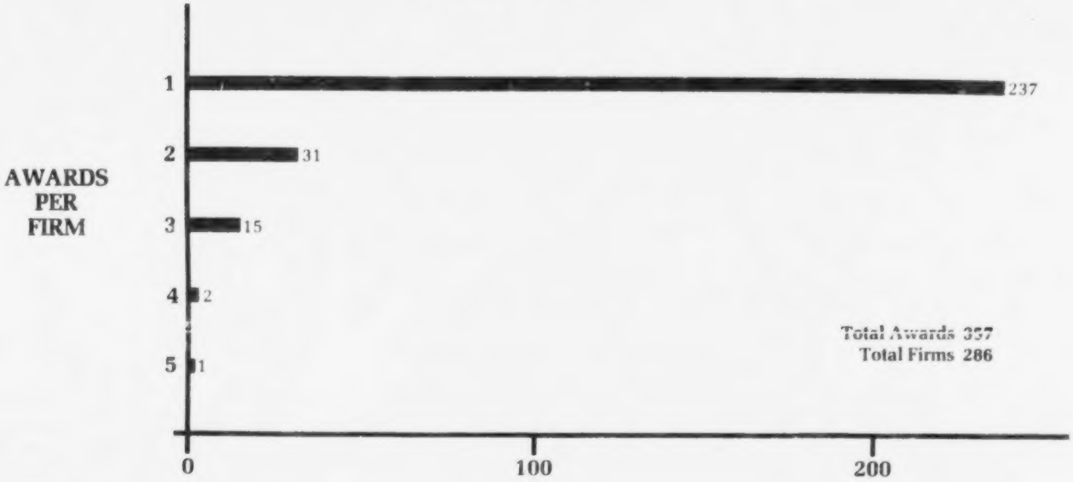
Total Awards 1,790
Total Firms 1,089

U.S. SMALL BUSINESS ADMINISTRATION

Office of Innovation, Research and Technology

SBIR Multiple Awards Statistics

FY 84 - Phase II

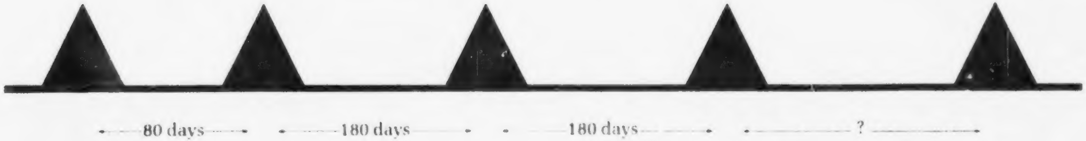


U.S. SMALL BUSINESS ADMINISTRATION

Office of Innovation, Research & Technology

Small Business Innovation Research Program

Acquisition Cycle



Phase I

Phase II

Agency Solicitation

Proposals Due

Evaluation and Award

Performance Final Report

Evaluation and Award

80 days

180 days

180 days

?

Senator **Rudman**. Thank you, Mr. Shane. We will have a few questions for the record.

[Subsequent information was received and follows:]

QUESTIONS AND ANSWERS FOR THE SMALL BUSINESS ADMINISTRATION

1. One of the biggest problems we have heard about the SBIR program is that the funding gap between the end of Phase I experimentation and the selection of Phase II awards can run from four to eighteen months. Is there anything that could be done to bridge that gap so as not to pose a barrier to small business participation?

   First, we would like to point out that a prudent funding gap is desirable and built into the process A careful review of the Phase I effort and the Phase II proposal allows agencies an opportunity to ensure that the proposing firm can conduct high quality R&D and has proven innovation feasibility before committing the much larger Phase II award. The delay also allows companies an opportunity to consider and develop commitments for Phase III funding needed for extra consideration when proposals are approximately equal. We feel that 4-6 months is a reasonable time and most agencies have no problem meeting this schedule. We will urge agency SBIR management to accelerate the process to a more reasonable time where necessary.

   The Department of Energy has attempted a solution to allow Phase I awardees to continue funding without any interruption. Awardees desiring this continuity submit their Phase II proposals early 60 days before Phase I normally ends. These proposals are evaluated and scored, and those with the highest scores continue directly into Phase II. Those with lower scores could still be funded, but not with continuity. They are held and compared with other Phase II proposals submitted at the regular time after completion of Phase I. A negative aspect is that it shortens the Phase I effort by one-third. While this option has been interesting for some SBIR awardees, the number of firms applying early for funding continuity has been declining.

   We will continue to review this situation and seek remedies if a problem exists with the awardees and the agencies.

2. In FY 83 and 84, we understand that award winners represented 46 states and the District of Columbia. There were three states that had one award winner and four that did not have any award winners. Can outreach efforts be improved to reach inventors and other innovative sectors of the economy currently not participating in the program?

The inclusion of the FY 85 statistics now available indicates that there are now three states that have received no awards, (North Dakota, Wyoming and Alaska) and two states that have received only one award, (West Virginia and South Dakota).

We will continue to seek outreach opportunities to assure that small businesses in all states are informed of the opportunities presented by the SBIR program. Our mailing list for Pre-Solicitation Announcements, for example, has over 40,000 names. We will continue to actively cooperate in providing information and speakers to states and state organizations requesting assistance in providing information on the program to small business and seek ideas to improve our outreach effort.

The Small Business Innovation Research awards are not and cannot be evenly distributed throughtout the United States. There are various reasons for this which include population density, the presence of government laboratories and purchasing centers, the mix of participating agencies, and established state industries and natural resources. The states on the lower end of the scale tend to be more rural and concentrated in agriculture industries. The agencies involved in these industries and states tend to have smaller extramural R&D budgets and consequently smaller SBIR programs.

We will continue our practice of supporting all persons and organizations who have an interest in the SBIR program.

3. Should there be a limit placed on the number of R&D awards a firm can receive in a given year?

Such a restriction could adversely affect the SBIR program in several ways:

a) SBIR is a highly competitive program with scientific and technical merit being most important criterion in the evaluation of proposals. A restriction on awards to a single firm could exclude excellent innovative ideas.

b) SBIR proposals respond to Federal R&D needs. A limit on awards to a single company may affect an agency's ability to pursue its R&D goals and national interests.

c) No competitive procurement program in the Federal Government has such a restriction.

SBA believes that the important issue is not the number of awards won by a company. Rather, it is the resolution of agency R&D needs and the ability of the company to conduct quality R&D and pursue successful commercialization for all its SBIR awards. These elements must be addressed by each agency in its evaluation process.

4. On page 13 of the Office of Innovation, Research and Technology's (OIR&T) second year report it states that approximately 20 percent of the R&D topics are not directed toward developing innovations. Mr. Shane, do you see that as a problem?

We currently do not consider the R&D topics as a problem. In a program of this breadth and magnitude it is unrealistic to expect all awards to yield high technological innovations and commercializations. The missions of the participating agencies vary greatly and a wide variety of elements under these agency missions are considered as R&D under OMB definitions.

In addition, there are mitigating factors:

- Many of the projects, identified as not directed toward developing innovations, are still within an agency's mission and needs and therefore fulfill one of the purposes of the SBIR program.

- Many of these projects are eliminated in the Phase II evaluation process.

- Our surveying and monitoring activities for the third year report indicate that the percentage of these projects is dropping.

5. We understand that the House Small Business Committee requested the Comptroller General to rule on whether or not the funds appropriated to DOD under category 6.6. "Operational Systems Development" are within the statutory definition of R&D for purposes of calculating its SBIR budget. Should DOD be required to replace the funds in future SBIR budgets which were excluded under 6.6, should it be decided that these activities are R&D for purposes of calculating the SBIR budget?

Public Law 97-219 clearly directed the Federal agencies concerning the Small Business Innovation Research Program. The law stated definitions for "extramural budgets" and "research" or "research and development". The definitions were not newly created but were from OMB circular (A-11) for the budget process. The law further provided a formula for expenditures in the program. Since program inception the DOD has made the unilateral decision that their 6.6 R&D funds should not be subjected to the SBIR budget process as directed by the law. Their opinion has been tested at the OMB; the NSF reporting group and now the GAO. All have concluded that the DOD is incorrect in its theory and that the only avenue open to DOD to not use 6.6 funds is to remove them from their R&D category in the DOD budget submissions and correct prior years accordingly.

The SBA has no authority to make a policy or decision which conflicts with the law. It is our belief that the DOD has only three approaches open to them; 1) change 6.6 to non-R&D funds; 2) request that the current law be changed or 3) follow the current law's direction. In a prior GAO decision concerning DOA it was determined that the SBIR budget did not have to come from a designated account but that the law directed that the total funding must be met.

6. How long has the SBA Commercilization Matching System (CMS) been in effect?

The Commercialization Matching System has been in effect for one year. The data base will shortly contain information on over 3200 SBIR projects and 520 sources of capital (evenly divided between venture capital firms and large corporations). To date, CMS has been used by 325 SBIR awardees, 110 large corporations, and 60 venture capital companies. For the most part the response has been enthusiastic; many sources of capital have already asked for additional searches. At this time the CMS is an evolving system, subjected to continuous updating and refinement as we attempt to incorporate feedback from users.

7. Does OIR&T plan to track the contacts made between venture capitalists and small businesses participating in the SBIR program?

In accordance with its surveying and monitoring responsibilities, SBA maintains continuous contact with SBIR awardees. SBA has visited over 100 awardees and has held in-depth discussions with many others by phone. Discussions include the company's plans and actions in attracting follow-on capital, if needed, for the commercialization of SBIR efforts. The sources of capital being pursued include not only venture capital but also major corporations, public offerings, bank financing, State pension funds, individual investors, etc.

In addition, SBA, through the venture capitalists and major corporations participating in the Commercialization Matching System, monitors the interest that sources of capital have for SBIR awardees.

SBA believes that tracking contacts is alone one element to be followed. An awardee with poor prospects for commercialization may contact many venture capitalists. Another awardee with excellent prospects may have internal resources for commercialization and, therefore, contact no one. SBA will continue to study the complex facets of the commercialization process. We recognize that contracts is a major element thereof, but it is only a part of the overall picture that we are all trying to understand.

8. Given the fact that the Office of Science and Technology Policy has limited its efforts in providing a technical evaluation of the research funded under the SBIR Program, has OIR&T considered other alternative methods by which a technical evaluation can be done on the program to ensure that only the soundest scientific proposals are being funded?

If the answer is yes, what are these suggestions?

Under the terms of Public Law 97-219 it was directed that the Director of the Office of Sceince and Technology Policy report not less than annually to the Senate and House of Representatives. The report was to consist of all the phases of implementation and operation of the SBIR programs in the agencies. On the surface this would appear to be a seemingly perfunctory directon. A review of legislative history delimits a greater intention. It is our opinion that the Congress envisioned an analysis of the technical output of the program. If it should be desirous of the Congress to seek an additional technical evaluation it would be prudent that such an analysis be performed by an objective organization with recognized credibility and no considered bias in the Program. The organization that best fits that profile is the General Accounting Office. The soundness of awardees SBIR funding agreements can be evaluated by them as to legislated program purposes and agency considered technical program value.

Senator **Rudman**. Ms. Frazier is here representing the GAO, and we are delighted to have you here this morning.

STATEMENT OF SARAH P. FRAZIER, ASSOCIATE DIRECTOR, RESOURCES, COMMUNITY AND ECONOMIC DEVELOPMENT DIVISION, U.S. GENERAL ACCOUNTING OFFICE

Ms. **Frazier**. Thank you, Mr. Chairman.

Senator **Rudman**. Your entire statement will be incorporated in the record, and you may summarize if you wish.

Ms. **Frazier**. Yes, sir. I do have a summary that I am prepared to present.

We are pleased to be here today to discuss the implementation of the Small Business Innovation Development Act of 1982. As you know, we recently issued a report—in October 1985—which reviews the extent to which the agencies established, funded, and provided accurate information on the activities required by the law. It also assesses program coordination, monitoring, and congressional reporting activities for the Small Business Administration and the Office of Science and Technology Policy.

Generally, we found that agencies have complied with the act's funding requirements but that most have not technically adhered to the act's reporting requirements. In the area of program oversight and monitoring, we found that the Small Business Administration has actively pursued and fulfilled its responsibilities under the act, while the Office of Science and Technology Policy has elected to limit its efforts.

In summarizing our statement, I would like to cover three areas briefly: First, SBIR programs; second, non-SBIR goals; and, third, program oversight. For ease of reference, I will refer to small business innovation research as SBIR.

First, regarding the SBIR programs: As you know, the act requires any Federal agency that spends more than $100 million annually on extramural or external research to establish a small business innovation research program. By the end of fiscal year 1984, we found 11 of 12 agencies which had met the external funding criteria had done so, had established such programs. These 11 agencies had issued 26 solicitations, received over 17,000 proposed projects, and had made almost 2,100 SBIR awards totaling $156 million. Mr. Shane has given you additional detail on these matters.

In regard to compliance by the agencies with the SBIR funding percentages, we found that most agencies had, in fact, either met the funding goals or come very close to the required percentages. There were two concerns that we found in this area.

First, in reporting funding data, estimated rather than actual data were submitted. We recommended that the Small Business Administration revise its reporting deadlines to facilitate agency reporting of actual obligations.

Second, a dispute existed between the Small Business Administration and the Department of Defense over the size of the Defense Department's extramural research budget. The difference was about $2 billion in 1984, which translates into about $11 million in SBIR funding. The discrepancy occurred because DOD used different definitions in reporting budget data to the Small Business Administration than to the National Science Foundation and OMB. We recommended that DOD report consistent figures to all agencies.

I will now move to the second area of non-SBIR goals. The act requires that all agencies with total research budgets exceeding $20 million set goals for awarding research funds to small businesses. These goals must be not less than the percentage of an agency's total research budget that went to small business the preceding year.

We could not say in our report whether the 18 agencies required to have non-SBIR goals actually met the goals because the data that they reported was in some cases inconsistent or in others inappropriate. However, we have recommended to the agencies that several steps be taken to rectify this situation and that they set meaningful goals.

Additionally, we have recommended that the Congress resolve an ambiguity in the act which makes it unclear under what conditions an agency meets the criteria for participation in and reporting on non-SBIR goals. We feel that this can be accomplished during reauthorization consideration for the SBIR Act.

Regarding the third area, program oversight, the Small Business Administration and the Office of Science and Technology Policy were assigned similar responsibilities for monitoring and reporting to Congress on the implementation of SBIR programs. We found that the Small Business Administration successfully made extensive efforts to fulfill its responsibilities under the act. They issued policy directives and made extensive efforts to stimulate small business participation, to coordinate agency solicitation, and to oversee and report on the implementation of the program.

In contrast, although the Office of Science and Technology Policy complied with statutory requirements, it purposely limited its efforts during the first 2 years of the program. OSTP said that it minimized its efforts for two reasons: First, to avoid duplication of the Small Business Administration's monitoring, and, second, because it believed the required duties were inappropriate and impractical given its mission and limited staff resources. The reports of the congressional authorizing committees in 1981, however, show that Congress expected OSTP to concentrate on assessing research quality, while the Small Business Administration was to protect the interests of small businesses. In this way, the roles of the two agencies would complement each other. We recommended, therefore, that OSTP monitor research quality using the Federal Coordinating Council for Science, Engineering, and Research to do so.

This concludes our statement, Mr. Chairman. We will be glad to answer any questions that you may have.

[The prepared statement of Ms. Frazier and questions and answers for GAO follow:]

United States General Accounting Office
Washington, D.C. 20548

FOR RELEASE ON DELIVERY
EXPECTED AT 9:30 A.M.
TUESDAY, MARCH 11, 1986

STATEMENT OF
SARAH P. FRAZIER, ASSOCIATE DIRECTOR
RESOURCES, COMMUNITY, AND ECONOMIC
DEVELOPMENT DIVISION
BEFORE THE
SUBCOMMITTEE ON INNOVATION
AND TECHNOLOGY
OF THE
SENATE COMMITTEE ON SMALL BUSINESS
ON
IMPLEMENTATION OF THE SMALL BUSINESS
INNOVATION DEVELOPMENT ACT OF 1982

Mr. Chairman and Members of the Subcommittee:

We are pleased to be here today at your request to discuss our October 25, 1985, report on the implementation of the Small Business Innovation Development Act of 1982. Our report (GAO/RCED-86-13) assesses the extent to which agencies established, funded, and provided accurate information on those activities required by the law. It also assesses program coordination, monitoring, and congressional reporting activities of the Small Business Administration (SBA) and the Office of Science and Technology Policy (OSTP).

We found that agencies have, for the most part, complied with the act's funding requirements, but that most have not fully adhered to the act's reporting requirements. In the area of program oversight and monitoring, we found that SBA has actively pursued and fulfilled its responsibilities, while OSTP has elected to limit its efforts.

I will briefly review some of the key provisions of the act, along with our findings.

SBIR PROGRAMS

The act requires each federal agency that spends more than $100 million annually on extramural research to establish a small business innovation research program. These programs, commonly called SBIR programs, are open only to small businesses. Agencies must spend specified percentages of their extramural funds on SBIR programs and must report program and funding data annually to both SBA and OSTP.

By the end of fiscal year 1984, 11 of 12 agencies meeting the extramural funding criterion established SBIR programs.

Together the 11 agencies had issued 26 solicitations, received over 17,000 proposed projects, and made almost 2,100 SBIR awards totaling $156 million.

The twelfth agency, the Department of Commerce, met the $100-million criterion in March 1984, when its budget estimate changed and reached the required amount. Commerce, however, said that it did not have time to fully implement an SBIR program before the end of the fiscal year. Commerce implemented its program early in fiscal year 1985 and planned to make up in fiscal year 1985 the amount it should have awarded during fiscal year 1984.

Technically, compliance with the act's SBIR funding percentages must be determined using actual obligations. Most agencies, however, have reported extramural figures to SBA reflecting estimated obligations or appropriations. This was done, by and large, because estimations were more readily available than actual obligations when the agencies had to report to SBA in late December. Most agencies said that it would be difficult to report the proper figures because doing so would require extra work for budget personnel who are already busy at that time of year preparing final budget submissions to the Office of Management and Budget. Most agencies said, however, that they could report actual extramural obligations by early March, which is the normal date for reporting these and other research funding data to the National Science Foundation (NSF).

We therefore recommended that SBA revise its reporting deadline to March 1, and that agencies report actual obligations. SBA and most of the affected agencies agreed with these recommendations. Using the actual obligation figures that agencies later reported to NSF, we determined that most agencies either met or came very close to meeting their required SBIR percentages.

There remains, however, an important outstanding dispute between SBA and the Department of Defense regarding the amount of DOD's extramural research budget. SBA considered the budget to be $17.9 billion for fiscal year 1984, while DOD contends that the proper figure is about $2 billion less. This translates into a difference of almost $11 million in the required SBIR funding. The discrepancy occurs because DOD inconsistently classifies the Operational Systems Development category of its research appropriations (category 6.6) when reporting research and development budget data to SBA, NSF, and OMB. This category includes those projects which are still in full-scale engineering development, but which have been approved for production. DOD excludes the category when reporting its extramural R&D budget to SBA, but includes this same category when reporting its R & D expenditures to NSF and to OMB. SBA uses the figures reported to NSF to estimate agencies' extramural research funding.

DOD excludes the 6.6 category when reporting to SBA because it contends that activities in the category do not conform to the act's definition of R & D. SBA maintains that NSF's definition of R & D is the same as that in the act. We agree that the definitions are the same and have recommended that DOD report consistent figures.

NON-SBIR GOALS

Because Congress intended that the SBIR program be a net addition to the agencies' existing small business research awards, all agencies with total research budgets exceeding $20 million are required to set goals for awarding research funds to small businesses. These goals must at least equal the percentage of an agency's total research budget that went to small businesses the preceding year; SBIR awards cannot be counted toward meeting an agency's non-SBIR goals.

Most of the 18 agencies required to have non-SBIR goals collected and reported fiscal year 1983 and 1984 goals data to SBA. However, in both fiscal years most agencies did not provide SBA with all the data needed to properly determine goal attainment. For example, in fiscal year 1983 some agencies reported no data at all, while others reported extramural rather than total research dollars as a base for their goals. While the quality of data improved in fiscal year 1984, the amount of total research dollars (the legislatively required basis for computing goals) that agencies reported to SBA differed from that reported in the President's budget. One reason for the inconsistency is that agencies do not normally make their budget figures final until after SBA's December reporting deadline.

We can't say at this time whether the agencies actually met their goals because the data reported to SBA were either inconsistent or inappropriate as a basis for judging goal attainment. We do, however, believe that certain actions should be taken in order to make goals meaningful targets for action.

In particular, we recommended that agencies set their goals at the beginning of the fiscal year and make those goals known to program officials responsible for awarding external R & D funds. The agencies should also collect the information needed to meet SBA's reporting requirements and to determine whether they have achieved their goals by the end of the year. Fewer than half the agencies followed all of these practices. While we realize that following our recommended practices will not guarantee goals achievement, we believe that they are preferable to leaving goals achievement essentially to chance by treating it as an after-the-fact reporting exercise, as many agencies have done so far. We also recommended that SBA change its deadline so that agencies could more easily report non-SBIR goals data.

One ambiguity in the goals requirement warrants the subcommittee's attention. It is not clear whether agencies whose research budgets had met the $20 million criterion must continue to set goals if they drop below $20 million in later years. This situation occurred at the Department of Housing and Urban Development, which met the criterion requiring goal setting in fiscal year 1983 but not in fiscal year 1984. As a result, HUD did not submit a 1984 annual report to SBA. We recommended that when the act is considered for reauthorization, the Congress make it clear that the $20 million criterion should be applied annually to identify those agencies that must establish goals.

PROGRAM OVERSIGHT

The act assigns the Small Business Administration and the Office of Science and Technology Policy similar responsibilities for monitoring and reporting to Congress on the implementation of SBIR programs.

We found that SBA has made extensive efforts to fulfill its responsibilities under the act. Specifically, we found that, as required, SBA issued policy directives for the conduct of the SBIR programs that complied with the act. Additionally, SBA made extensive efforts to stimulate small business participation, to coordinate agency solicitations, and to oversee and report on program implementation.

The act requires the Office of Science and Technology Policy--in consultation with an interagency group, the Federal Coordinating Council for Science, Engineering and Research--to independently survey, monitor, and report to the Congress on the implementation and operation of the SBIR programs. Although OSTP has complied with the requirements for monitoring, surveying and reporting to Congress, it has purposely limited its activity during the first 2 years of the program and has not assessed the quality of the research as envisioned in the reports of the House and Senate Small Business Committees. Thus, the Director of OSTP has not utilized the Federal Coordinating Council for SPIR oversight and OSTP staff have conducted a very limited review of the program. OSTP's first annual report to the Congress was a 1-page letter that contained little support for its conclusion that the SBIR agencies were all making "good faith" efforts to accomplish the purposes of the act.

OSTP limited its activity for two reasons--a belief that the required duties are inappropriate and impractical given OSTP's mission and its limited staff resources, and a desire to avoid duplication of what OSTP believes to be adequate monitoring by SBA. The reports of the authorizing committees, however, indicate that the Congress expected OSTP to concentrate on assessing research quality, while SBA would protect the interests of small businesses so that the monitoring roles of the two agencies would complement rather than duplicate each other. We recommended, therefore, that OSTP monitor research quality, utilizing the Federal Coordinating Council for Science, Engineering and Research to do so.

This concludes my statement, Mr. Chairman. I will be happy to respond to any questions.

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY,
AND ECONOMIC DEVELOPMENT
DIVISION

12 MAY 1986

The Honorable Lowell Weicker, Jr.
Chairman, Committee on Small Business
United States Senate

Dear Chairman Weicker:

As requested by your May 7, 1986, letter to Skip Jenkins of my staff, the following are our responses to three questions related to the General Accounting Office's testimony at the Committee's March 11, 1986, hearing on the Small Business Innovation Research (SBIR) Program.

1. Has the Comptroller General rendered a decision on whether or not the activities conducted under category 6.6 are R&D for purposes of calculating DOD's SBIR budget?

   If the answer is yes, please forward a copy of the decision to the Small Business Committee.

GAO Response:

Yes. The Comptroller General's February 21, 1986, letter (B-209790) to the Chairman, House Committee on Small Business, concluded that activities conducted under "Operation System Development" (category 6.6) funds are within the definition of research and development contained in the Small Business Innovation Development Act of 1982 (Public Law 97-219), and that the extramural portion of such funds thus should be included in calculating the Department of Defense's annual minimum SBIR funding requirement. The Comptroller General's letter also mentioned several practical difficulties that DOD officials told us could result from this practice. In light of these potential difficulties, we suggested that the House Committee may wish to consider whether the category 6.6 activities should be exempted from the act. A copy of the Comptroller General's letter is enclosed.

2. Does GAO plan to conduct another report on the SBIR program prior to its July 1987 "Capping Report" which is mandated under P.L. 97-219?

   If the answer is yes, what will be the objective(s) of this report?

GAO Response:

Yes. GAO currently has underway a review of federal agencies' SBIR award procedures (job code 005715). The objectives of this review are to:

- --Determine the ways in which the agencies have made SBIR award and administration procedures simplified, timely, and less burdensome for small businesses;
- --Determine if agencies evaluate and select SBIR projects on the basis of merit; and
- --Determine the extent to which agencies' procedures consider innovation and commercialization potential in the selection of SBIR projects.

We anticipate issuing a report on this review in March 1987.

Shortly after our testimony, we also issued a fact sheet entitled Research and Development: A Profile of Selected Firms Awarded Small Business Innovation Research Funds (GAO/RCED-86-113FS, Mar. 21, 1986) to the Chairman, Subcommittee on General Oversight and the Economy, House Committee on Small Business. Copies of this document were provided to Mr. Waddell of the Senate Small Business staff at that time.

3. Has GAO formulated any thoughts to how it will approach its reporting requirement on the "Nature of Research" funded under the SBIR Program?

GAO Response:

GAO has informally sought suggestions in this regard from the participating federal agencies and from the Small Business Administration. The participating agencies publish abstracts describing each of their SBIR projects. Because of the large number of SBIR projects and the highly technical nature of the abstracts, they would not, in our view, be a particularly useful form of information for the congressional reauthorization process. None of the participating agencies were able to suggest any form of summary information in this regard.

SBA classifies the participating agencies' SBIR projects into 7 broad technology areas, which correspond to the 2-digit Standard Industrial Code (SIC). SBA already publishes this classification in its annual report to the Congress on the SBIR program. To our knowledge, this is the only currently available summary information indicative of the "nature" of SBIR research.

Given this situation, GAO plans to seek suggestions from the House and Senate Small Business and other interested Committees as to the specific additional information (if any) regarding the nature of SBIR research that they would find useful in deliberating the act's reauthorization. We will be contacting the Committee staffs within the next several months to obtain suggestions.

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We appreciate the opportunity to assist the Committee's oversight of the SBIR program. If you have further questions or need additional information, please call me on 275-7783.

Sincerely yours,

Sarah P. Frazier

Sarah P. Frazier
Associate Director

Enclosure

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. [illegible]

B-209790

February 21, 1986

The Honorable Parren J. Mitchell
Chairman, Committee on Small Business
House of Representatives

Dear Mr. Chairman:

This is in response to your letter of November 20, 1985, in which you were joined by four other committee members, concerning the applicability of the definition of "research" or "research and development" (R&D) appearing in section 4 of Public Law 97-219, the Small Business Innovation Development Act of 1982, to certain Department of Defense (DOD) activities. More specifically, you refer to funds in DOD's "Operational System Development", category 6.6, and request our opinion as to whether activities funded under this category are within the statutory definition.

In your letter, you mention our report to the Congress, dated October 25, 1985, "Implementing the Small Business Innovation Development Act--The First 2 Years", GAO/RCED-86-13. In it we discussed a disagreement between the Small Business Administration (SBA) and DOD concerning DOD's failure to report Operational System Development as extramural R&D under the Act, while at the same time reporting the same activities as research to the National Science Foundation and in the Office of Management and Budget's summary of Federal research funds in the President's budget (Special Analysis K). We recommended that the Secretary of Defense definitively determine which activities funded under the Operational System Development Category of DOD's Research, Development, Testing and Evaluation (RDT&E) appropriations conform to the common definition of R&D found in the Small Business Innovation Development Act, the National Science Foundation's annual survey of Federal R&D funds, and the special analysis of Federal R&D funds in the President's budget. We also recommended that that determination then consistently be applied when reporting R&D funding data to the three recipients. Our discussion is found at pages 22-26, 29-31 of the report. You now ask for a GAO ruling on whether the activities funded under category 6.6 meet the definition of R&D.

> "Includes those projects in full scale engineering development for Service use but which have not yet received approval for production or had production funds included in the DoD budget submission for the budget or subsequent fiscal year. This area is characterized by major line item projects * * *."

In the case of DOD, category 6.6, "Operational System Development" is described as "full scale engineering development," and is included in RDT&E appropriations. We have no reason to think that this characterization is inaccurate. The Act's definition of R&D includes the "design, development, and improvement of prototypes and new processes to meet specific requirements."

We note that the description of activities for "Operational System Development" and "Engineering Development" is similar, and yet DOD has only considered the latter to be R&D for SBIR purposes. The difference appears to be that under category 6.6, "Operational System Development," the development is related to weapons systems in production or nearing production. However, the statutory definition of R&D would apply to this circumstance as well as one in which the development is for an entirely new weapons system or component.

Subsequent to the receipt of your request for our opinion, our staff met with officials of the Directorate for R&D of the DOD Controller's Office. Our staff was told that both categories encompass development activities within the scope of the R&D definition in the Small Business Innovation Development Act. It was explained that DOD had objected to the inclusion of "Operational System Development" activities within the scope of the Act because when production had already commenced, the development contract by necessity was awarded to the contractor producing the system or component. Thus, there were few opportunities for others, including small businesses, to do the development work. According to the DOD officials, in this circumstance the inclusion of category 6.6 amounts in the overall R&D totals would lead to increased SBIR awards in other R&D areas, possibly overburdening them. Notwithstanding this, the DOD officials now agree that the category 6.6 activities are R&D in nature.

Senator RUDMAN. Thank you very much, Ms. Frazier.

I take it from your testimony that considering this is essentially a new law with all new requirements for 11 agencies, that by and large, compared to some GAO reports I have seen on old laws, there was good compliance.

Ms. FRAZIER. Yes, sir. Indeed, we found that the 12 agencies that met the criteria had made a good-faith effort and had been, by and large, quite successful in doing so.

Senator RUDMAN. I take it your major suggestion, which I think is a very good one, is that the reporting dates be changed to enable the data that is reported to be actual rather than estimated.

Ms. FRAZIER. Yes, sir. We recommended that, and the Small Business Administration has acted on those suggestions and recommendations.

Senator RUDMAN. As far as your suggestion on statutory change, I think we would probably agree with that. I think we also have to take another look at the role of OSTP. There is a political history as to why that was put in the law. I would have been very pleased to have it just be the SBA because I think there are some duplicative efforts that result from that. But we will have to look at that in our hearing.

Thank you very much.

Ms. FRAZIER. You are welcome.

Senator RUDMAN. Dr. Leo Young is from DOD. If you could summarize, I have a few questions for you. I am going to have several for the record as well. Your entire statement will be in the hearing record.

STATEMENT OF DR. LEO YOUNG, DIRECTOR FOR RESEARCH AND LABORATORY MANAGEMENT, OFFICE OF THE DEPUTY UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ADVANCED TECHNOLOGY, U.S. DEPARTMENT OF DEFENSE, ACCOMPANIED BY HORACE CROUCH, DEPUTY CHAIRMAN, SBIR PROGRAM, U.S. DEPARTMENT OF DEFENSE

Dr. YOUNG. I will just summarize my remarks, Senator Rudman.

It is a real pleasure to be here again to testify before you once more on SBIR. My name is Leo Young, Director for Research and Laboratory Management in the Office of the Deputy Under Secretary of Defense for Research and Advanced Technology.

This morning I will discuss the implementation of and the experience in fiscal years 1984 and 1985 with the DOD Small Business Innovation Research Program established in accordance with Public Law 97-219.

I have with me Mr. Horace Crouch, Deputy Director of the Office of Small and Disadvantaged Business Utilization. We work together.

Public Law 97-219 required that, beginning in fiscal year 1983, the Department of Defense make available a specified percentage of its extramural research and development budget to small high technology companies competing in the SBIR Program. The required percentages rose progressively from 0.1 percent in 1983 to 1.25 percent in fiscal year 1987.

Projected funding requirements for the SBIR Program are based on DOD's R&D budget category 6.1, basic research; 6.2, exploratory development; 6.3, advanced development; 6.4, engineering development; and 6.5, management and support, in equal proportions.

The DOD excluded operational systems development, often referred to as budget category 6.6 although it does not exist as such, from the SBIR funding base, because this form of development applies to weapons systems already approved for development or already in production.

Production and operational use of weapons systems often uncover deficiencies and make corrective design changes necessary for adequate system performance. The so-called 6.6 category is reported as a financial measure of the totality of these corrective actions which in most cases can only be undertaken by those specific contractors and subcontractors who develop and are producing the baseline system or components.

For fiscal year 1984, the DOD extramural R&D was $15 billion, and the required SBIR set-aside of 0.3 percent amounted to $43 million. The services, the Defense Advanced Research Projects Agency [DARPA], and the Defense Nuclear Agency [DNA], selected 565 topics which were announced in the annual phase I solicitation on October 1, 1983. The 1984 phase I solicitation, which closed on January 31, 1984, generated over 3,000 proposals from which 369 were funded in phase I contracts at an average amount of $52,000 for a total of $19 million.

Phase II proposals are submitted only by winners of phase I awards. There is no phase II solicitation. Phase II awards are not automatic. About 50 percent of phase I awards have resulted in phase II awards, which we consider to be very satisfactory. Detailed instructions regarding phase II proposal submission are sent by DOD components to all of their phase I award winners.

In fiscal year 1984, the DOD received 171 phase II proposals from fiscal year 1983 phase I winners and selected 152 of those to be funded. Twenty-two million dollars from the fiscal year 1984 SBIR budget were used for first-year funding of 115 selections, and the 37 remaining selections are being funded in the fiscal year 1985 SBIR budget.

DOD also awarded $3 million to phase II projects from our earlier voluntary program, the Defense Small Business Advanced Technology [DESAT] Program. The total amount of funds expended on phase I and phase II awards in the DOD SBIR Program in 1984 was over $44 million.

For fiscal year 1985, the services, DARPA, and DNA developed 490 topics for our annual phase I solicitation announced on October 1, 1984, and closed January 31, 1985. A supplemental solicitation for 16 topics furnished by the Strategic Defense Initiative Organization [SDIO] was issued on January 1, 1985, and closed March 31, 1985.

More than 3,500 proposals were received from both solicitations, and 542 proposals have been selected for funding in phase I. Fiscal year 1985 SBIR funds in the amount of $28 million were used to fund 516 selections, while 26 will be funded with fiscal year 1986 dollars. Average funding level for phase I awards from the fiscal year 1985 program is $54,000.

The evaluation process and contract negotiations have not been completed on many of the 250 phase II proposals received from the 1984 phase I winners. To date, 140 proposals have been selected to be funded in the first year with $25 million from the 1985 SBIR budget.

We estimate that an additional 10 to 20 of the remaining phase II proposals will be funded in the first year with 1986 dollars. In addition, 1985 funds are being used for second-year funding of 130 phase II projects from the fiscal year 1983 phase I winners. The total amount is $23 million. DOD also awarded $2 million to phase II DESAT projects. Our total phase I and phase II awards funded from the 1985 budget are $78 million.

The SBIR Program has come a long way since the early days of the DESAT Program in DOD. We are very enthusiastic about the program and feel it has been a real benefit to DOD while also providing valuable new opportunities for small business. To maximize these opportunities, the Defense Technical Information Center has greatly assisted by providing timely and relevant technical information to potential SBIR bidders.

The DOD has long been sensitive to the needs of small business. The voluntary DESAT Program that preceded the SBIR Act is an example of DOD early activity to increase the participation of small R&D firms of this Nation in the innovative process. It is our view that the current act is fundamentally sound, is working well, and should continue for the immediate future.

Mr. Chairman, we appreciate the opportunity to testify on the Small Business Innovation Development Program. We are proud of what DOD and its small business contractors have accomplished by working together in almost 6 years of SBIR and DESAT Programs.

Thank you very much.

[The prepared statement of Dr. Young follows:]

Hold Until Released by
the Subcommittee

THE DEPARTMENT OF DEFENSE

STATEMENT ON

IMPLEMENTATION OF THE SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

BEFORE THE
SUBCOMMITTEE ON INNOVATION AND TECHNOLOGY
OF THE
COMMITTEE ON SMALL BUSINESS
UNITED STATES SENATE
MARCH 11, 1986

BY

DR. LEO YOUNG
DIRECTOR FOR RESEARCH AND LABORATORY MANAGEMENT
OFFICE OF THE DEPUTY UNDER SECRETARY OF DEFENSE
(RESEARCH AND ADVANCED TECHNOLOGY)

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE:

I AM LEO YOUNG, DIRECTOR FOR RESEARCH AND LABORATORY MANAGEMENT IN THE OFFICE OF THE DEPUTY UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ADVANCED TECHNOLOGY. THIS MORNING I WILL DISCUSS THE IMPLEMENTATION OF AND THE EXPERIENCE THUS FAR WITH THE DOD SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM, ESTABLISHED IN ACCORDANCE WITH P.L. 97-219. I HAVE WITH ME MR. HORACE CROUCH, DEPUTY DIRECTOR OF THE OFFICE OF SMALL AND DISADVANTAGED BUSINESS UTILIZATION AND NELSON EATON, DIRECTOR, RESEARCH AND DEVELOPMENT IN THE OFFICE OF THE DEPUTY ASSISTANT SECRETARY OF DEFENSE (PROGRAM/BUDGET).

THE DEPARTMENT OF DEFENSE RECOGNIZES THAT THE CAPABILITIES AND EXPERIENCE OF SMALL BUSINESS IN HIGH TECHNOLOGY AREAS CAN AND HAVE MADE A VALUABLE CONTRIBUTION TO THE RESEARCH AND DEVELOPMENT REQUIREMENTS OF DOD. A VOLUNTARY PROGRAM TO ENCOURAGE DOD-RELATED RESEARCH AND DEVELOPMENT IN SMALL FIRMS WAS INSTITUTED IN FY 1982: THE DEFENSE SMALL BUSINESS ADVANCED TECHNOLOGY (DESAT) PROGRAM. THE NATIONWIDE ANNOUNCEMENT OF THE DESAT PROGRAM RESULTED IN 1100 PROPOSALS OF WHICH 100 PHASE I AWARDS WERE MADE FOR A TOTAL OF $5.0 MILLION IN FY 1982. OF THE PHASE I WINNERS, 33 WERE SELECTED FOR PHASE II AWARDS FOR A TOTAL OF $4.8 MILLION IN FY 1983, $3.0 MILLION IN 1984 AND $1.9 MILLION IN 1985. TWO DESAT PROJECTS

HAVE PROVIDED INNOVATIVE TECHNOLOGY USEFUL TO THE DOD NEEDS AND ARE CURRENTLY BEING FUNDED IN PHASE III BY DOD WITH NON-SBIR FUNDS. THE SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM LEGISLATED IN THE SMALL BUSINESS INNOVATION DEVELOPMENT ACT OF 1982 CLOSELY RESEMBLES THE DESAT PROGRAM. THIS GAVE DOD A RUNNING START AND RESULTED IN A SMOOTH TRANSITION FROM DESAT TO SBIR.

THE EXECUTION OF THE SBIR PROGRAM IN DOD IS DECENTRALIZED. THE ARMY, NAVY, AIR FORCE, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA), DEFENSE NUCLEAR AGENCY (DNA), AND THE STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO JOINED THE SBIR PROGRAM IN FY 1985) INDEPENDENTLY SELECT THE RESEARCH AND DEVELOPMENT TOPICS WHICH ARE PUBLISHED IN THE SBIR SOLICITATION BROCHURE, REVIEW PROPOSALS RECEIVED IN RESPONSE TO THE ADVERTISED TOPICS, AND SELECT THE WINNING PROPOSALS. I PROVIDE DIRECTION, OVERSIGHT AND COORDINATION FOR THE PROGRAM THROUGH THE DEFENSE SMALL BUSINESS INNOVATION RESEARCH COMMITTEE (DESIC), OF WHICH I AM CHAIRMAN AND MR. CROUCH IS DEPUTY CHAIRMAN. THE COMMITTEE IS COMPRISED OF REPRESENTATIVES FROM THE SERVICES AND DEFENSE AGENCIES.

THE PRIMARY FUNCTIONS OF THE COMMITTEE ARE TO ACT AS OVERALL FOCAL POINT FOR SBIR; TO ENSURE COORDINATION AMONG THE DOD AGENCIES; TO COLLECT RESEARCH TOPIC DESCRIPTIONS AND PUBLISH THE SOLICITATION BROCHURES; TO PUBLICIZE THE PROGRAM WITHIN THE SMALL

BUSINESS COMMUNITY; AND TO COLLECT DATA REQUIRED TO EVALUATE THE PROGRAM AND TO PREPARE MANDATED REPORTS. THE MEETINGS OF THE DESIC COMMITTEE PROVIDE A FORUM FOR THE PARTICIPATING AGENCIES TO DISCUSS COMMON ISSUES WHICH ARISE AND TO ENSURE CONSISTENCY IN IMPLEMENTATION OF THE PROGRAM AMONG THE AGENCIES.

THE SERVICES AND DEFENSE AGENCIES DETERMINE THEIR SBIR RESEARCH TOPICS INDEPENDENTLY ACCORDING TO THEIR CURRENT TECHNOLOGY NEEDS AND REQUIREMENTS. THE TOPIC DESCRIPTIONS ARE COLLECTED BY THE OFFICE OF THE SECRETARY OF DEFENSE AND INTEGRATED INTO A SINGLE SBIR SOLICITATION BROCHURE. PRIOR TO RELEASE OF THIS DOCUMENT, THE SMALL BUSINESS ADMINISTRATION IS GIVEN THE LIST OF TOPICS FOR PUBLICATION IN ITS NEXT QUARTERLY PRESOLICITATION ANNOUNCEMENT.

THE SOLICITATION BROCHURE IS DISTRIBUTED WIDELY BY DIRECT MAILINGS USING THE SBA SBIR SOURCE LIST. IN ADDITION, THE PROGRAM IS ADVERTISED IN R&D TRADE ASSOCIATION MAGAZINES AND APPEARS ON THE FRONT PAGE OF THE COMMERCE BUSINESS DAILY. REQUESTS FOR BROCHURES ARE DIRECTED TO THE DEFENSE TECHNICAL INFORMATION CENTER. FINALLY, DOD REPRESENTATIVES ATTEND SPECIAL CONFERENCES FOR SMALL FIRMS ORGANIZED BY SBA, NSF, MEMBERS OF CONGRESS, AND THE STATES. MORE THAN 100 SUCH CONFERENCES HAVE BEEN ATTENDED BY DOD REPRESENTATIVES SINCE THE PROGRAM BEGAN IN 1983. FOR THE

SOLICITATIONS RELEASED FROM 1983 TO 1986, A TOTAL OF APPROXIMATELY 150,000 BROCHURES WERE DISTRIBUTED, 100,000 BY MAILINGS AND 50,000 MORE AT CONFERENCES.

THE DEFENSE TECHNICAL INFORMATION CENTER (DTIC) PLAYS A VITAL ROLE IN STRENGTHENING PROPOSAL SUBMISSIONS TO SBIR BY PROVIDING SPECIAL TECHNICAL INFORMATION SUPPORT TO POTENTIAL OFFERORS. DTIC ASSEMBLES A PACKAGE OF BIBLIOGRAPHIC CITATIONS OF UNCLASSIFIED TECHNICAL REPORTS AND DESCRIPTIONS OF CURRENT DOD-SPONSORED R&D PROGRAMS FOR EACH TOPIC APPEARING IN THE SOLICITATION BROCHURE. DTIC ALSO WILL PROVIDE COPIES OF PARTICULAR REPORTS APPEARING IN THE BIBLIOGRAPHIES ON REQUEST. SBIR PARTICIPANTS ARE GIVEN ACCESS TO DTIC MANAGED INFORMATION ANALYSIS CENTERS (IACS) WHICH PROVIDE INFORMATIONAL AND CONSULTATIVE SERVICES IN SPECIALIZED R&D AREAS. DURING THE MOST RECENT SBIR SOLICITATION PERIOD WHICH CLOSED JANUARY 31, 1986, DTIC PROVIDED 28,477 TECHNICAL INFORMATION PACKAGES AND 15,081 COPIES OF TECHNICAL REPORTS TO 3,031 SMALL FIRMS RESPONDING TO 760 SOLICITATION TOPICS. BY PROVIDING THIS CAREFULLY TAILORED TECHNICAL INFORMATION, DTIC PERFORMS A KEY SERVICE FOR BOTH DOD AND THE SMALL BUSINESS COMMUNITY. THE WASTED EFFORT AND COST ASSOCIATED WITH PREPARATION OF PROPOSALS WHICH DUPLICATE COMPLETED OR ON-GOING R&D IS REDUCED, WHILE OTHER PROPOSALS WHICH MAY INCORPORATE RESULTS OF PREVIOUS, RELATED RESEARCH ARE STRENGTHENED.

IN ADDITION TO DTIC SERVICES, SMALL BUSINESS FIRMS INTERESTED IN PARTICIPATING IN THE SBIR PROGRAM MAY ALSO SEEK GENERAL ADMINISTRATIVE GUIDANCE FROM SMALL AND DISADVANTAGED BUSINESS UTILIZATION SPECIALISTS LOCATED IN VARIOUS DEFENSE CONTRACT ADMINISTRATION SERVICES (DCAS) ACTIVITIES THROUGHOUT THE UNITED STATES. THESE SPECIALISTS, IDENTIFIED IN THE SOLICITATION BROCHURE, ARE AVAILABLE TO DISCUSS GENERAL ADMINISTRATIVE REQUIREMENTS TO FACILITATE THE SUBMISSION OF PROPOSALS AND EASE THE ENTRY OF THE SMALL HIGH TECHNOLOGY BUSINESS INTO THE DEPARTMENT OF DEFENSE MARKETPLACE.

THE PROCESS OF SBIR PROPOSAL EVALUATION AND SELECTION OF WINNING PROPOSALS IS SIMILAR AMONG THE SERVICES AND DEFENSE AGENCIES. PHASE I PROPOSALS IN EACH TOPIC AREA ARE EVALUATED ON A COMPETITIVE BASIS WITHIN THE ORGANIZATION WHICH GENERATED THE TOPIC. THE PROPOSALS ARE FIRST SCREENED TO ELIMINATE THOSE WHICH OBVIOUSLY ARE NOT RELEVANT TO THE CHOSEN TOPIC. THE REMAINDER IN EACH TOPIC AREA ARE EVALUATED BY SCIENTISTS AND ENGINEERS KNOWLEDGEABLE IN THAT AREA.

FINAL DECISIONS ON FUNDING ARE MADE INDEPENDENTLY BY THE PARTICIPATING AGENCIES BASED ON THE TECHNICAL EVALUATION ALONG WITH CONSIDERATION OF OTHER FACTORS, INCLUDING POSSIBLE

DUPLICATION BY OTHER ONGOING WORK AND THE OVERALL R&D PROGRAM BALANCE. CONTRACT NEGOTIATION FOR A SUCCESSFUL PROPOSAL IS CARRIED OUT BY THE LOCAL CONTRACTING OFFICE NORMALLY USED BY THE DOD ORGANIZATION WHICH PERFORMED THE TECHNICAL EVALUATION.

PHASE II PROPOSALS ARE SUBMITTED ONLY BY WINNERS OF PHASE I AWARDS; THERE IS NO PHASE II SOLICITATION. ALSO, PHASE I WINNERS DO NOT GUARANTEE PHASE II AWARDS, DETAILED INSTRUCTIONS REGARDING PHASE II PROPOSAL SUBMISSION ARE SENT BY DOD COMPONENTS TO ALL OF THEIR PHASE I AWARD WINNERS.

PHASE II PROPOSALS ARE SUBJECTED TO A TECHNICAL REVIEW PROCESS SIMILAR TO THAT FOR PHASE I. FINAL DECISIONS ARE MADE BY DOD COMPONENTS BASED UPON SCIENTIFIC AND TECHNICAL MERIT AND POSSIBLY PHASE III FOLLOW-ON FUNDING COMMITMENT (NON-SBIR FUNDING), THE AVOIDANCE OF DUPLICATION WITH OTHER RESEARCH AND DEVELOPMENT EFFORTS, AND PROGRAM BALANCE.

PUBLIC LAW 97-219, THE SMALL BUSINESS INNOVATION DEVELOPMENT ACT OF 1982, REQUIRED THAT THE DOD MAKE AVAILABLE THE FOLLOWING PERCENTAGES OF ITS EXTRAMURAL R&D BUDGET FOR THE SBIR PROGRAM BEGINNING WITH THE FISCAL YEAR 1983:

TABLE I

DOD EXTRAMURAL R&D BUDGET PERCENTAGES AND TOTAL R&D SET-ASIDES FOR SMALL BUSINESS

	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988*
Total Extramural R&D Budget	$13.678B	$15.665B	$16.276B	-	-	-
Percentage	0.10	0.30	0.50	1.00	1.25	1.25
Estimated Dollars	$16.7M	$43.0M	$79.0M	$160.0M	$204.0M	$262.0M
Actual Awarded Dollars	$20.6M	$44.6M	$78.2M**	-	-	-
Total R&D Set Aside for Small Business	$105.5M	$172.8M	$295.8M	-	-	-

PROJECTED FUNDING REQUIREMENTS FOR THE SBIR PROGRAM ARE BASED ON DOD'S RESEARCH AND DEVELOPMENT BUDGET CATEGORIES 6.1 (BASIC RESEARCH), 6.2 (EXPLORATORY DEVELOPMENT), 6.3 (ADVANCED ARE NOT DEVELOPMENT), 6.4 (ENGINEERING DEVELOPMENT), AND 6.5 (MANAGEMENT AND SUPPORT).

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* FY 1988 NUMBERS ARE ONLY FOR PLANNING PURPOSES.

** ON JANUARY 16, 1986 THERE WAS A 5.039 PERCENT DEFERRAL OR REDUCTION ON THE FY 1985 UNOBLIGATED FUNDS OF ALL PROGRAMS, PROGRAM ELEMENTS, PROJECTS, AND ACTIVITIES BASED ON THE GRAMM/RUDMAN/HOLLINGS BILL. THE DOD SBIR BUDGET FOR FY 1985 WAS REDUCED BY $1.8 MILLION. OMB BULLETIN 86-7, 16 JAN 86.

THE DOD EXCLUDED OPERATIONAL SYSTEMS DEVELOPMENT (OFTEN REFERRED TO AS "BUDGET CATEGORY 6.6") FROM THE SBIR FUNDING BASE BECAUSE THIS FORM OF DEVELOPMENT APPLIES TO WEAPON SYSTEMS ALREADY APPROVED FOR DEPLOYMENT OR ALREADY IN PRODUCTION. PRODUCTION AND OPERATIONAL USE OF WEAPON SYSTEMS OFTEN UNCOVER DEFICIENCIES AND MAKE CORRECTIVE DESIGN CHANGES NECESSARY FOR ADEQUATE SYSTEM PERFORMANCE. THE "6.6" CATEGORY IS REPORTED AS A FINANCIAL MEASURE OF THE TOTALITY OF THESE CORRECTIVE ACTIONS WHICH IN MOST CASES CAN ONLY BE UNDERTAKEN BY THOSE SPECIFIC CONTRACTORS AND SUBCONTRACTORS WHO DEVELOP AND ARE PRODUCING THE BASELINE SYSTEM OR COMPONENTS.

THESE SO-CALLED "6.6" FUNDS DO NOT AFFORD ANY NEW SMALL BUSINESS COMPETITION OPPORTUNITY AND SHOULD NOT BE INCLUDED FOR THE PURPOSE OF ESTABLISHING SMALL BUSINESS PARTICIPATION GOALS UNDER P.L. 97-219. THE DOD STRONGLY SUPPORTS THE OBJECTIVES OF THE SBIR ACT AND HAS EXCEEDED OR MET THE ANNUAL GOALS FOR THE SBIR PROGRAM IN FY 1983, FY 1984, AND FY 1985.

THE TABLE BELOW CONTAINS DOD PERFORMANCE DATA FOR FY 1983 THROUGH FY 1985:

TABLE II

FY 1983 - FY 1985 SBIR PROGRAMS

FY	Phase I Proposals Received	Phase I Awards Made	Funds Awarded	Average Amount Awarded	Phase II Awards
83	2902	283	$15.795M	$56.0K	152
84	3012	369	$19.405M	$52.5K	140
85	3517	516*	$28.010M	$54.2K	-

FOR THE INITIAL YEAR OF THE DOD SBIR PROGRAM, FY 1983, THE REQUIRED FUNDING FOR DOD WAS 0.1 PERCENT OF THE EXTRAMURAL BUDGET OF $13.678 BILLION. THE SERVICES, DARPA, AND DNA SELECTED 406 RESEARCH AND DEVELOPMENT TOPICS WHICH WERE INCLUDED IN THE ANNUAL SBIR SOLICITATION BROCHURE. TABLE II SHOWS THE BREAKOUT OF THE PROPOSALS RECEIVED, AWARDS MADE, AND ASSOCIATED FUNDING LEVELS OF PHASE I AWARDS. COUNTING THE PHASE II DESAT AWARDS OF $4.8 MILLION TOTAL AWARDS CREDITED TO THE FY 1983 PROGRAM AMOUNTED TO $20.6 MILLION. THESE AWARDS SUBSTANTIALLY EXCEEDED OUR ESTIMATED, MANDATORY FUNDING LEVEL OF $16.7 MILLION. SUBSEQUENTLY PHASE I CONTRACTS THAT BEGUN IN FY 1983 RESULTED IN 171 PHASE II PROPOSALS; 152 OF THESE WERE FUNDED OUT OF THE FY 1984 AND FY 1985 SBIR APPROPRIATIONS.

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* 26 ADDITIONAL AWARDS WILL BE FUNDED BY THE ARMY WITH FY 1986 FUNDS.

IN A FURTHER EFFORT TO STRENGTHEN THE PROGRAM, DTIC GAVE SUBSTANTIAL ASSISTANCE TO MORE THAN HALF OF THE FY 1983 PHASE I AWARDEES BY PROVIDING TO THE PRINCIPAL INVESTIGATORS NARROWLY TARGETED AND MORE COMPLETE TECHNICAL REPORT BIBLIOGRAPHIES AND ONGOING RESEARCH SUMMARIES ON THEIR PROJECT TOPICS. SUCH INFORMATION REDUCED THE CHANCE OF UNNECESSARY DUPLICATION OF PRIOR OR ON-GOING RESEARCH AND DEVELOPMENT WORK AND HELPED ESTABLISH COMMUNICATION AMONG INVESTIGATORS WORKING ON RELATED PROJECTS. THIS SERVICE HAS CONTINUED FOR BOTH PHASE I AND PHASE II AWARD WINNERS.

DURING THE SECOND YEAR OF THE DOD SBIR PROGRAM, FY 1984, THE DOD WAS REQUIRED TO MAKE AVAILABLE 0.3 PERCENT ($43M) OF ITS EXTRAMURAL RESEARCH AND DEVELOPMENT BUDGET ($15.665 BILLION) FOR THE SBIR PROGRAM. THE SERVICES, DARPA, AND DNA DEVELOPED 565 RESEARCH AND DEVELOPMENT TOPICS, WHICH WERE ANNOUNCED IN THE ANNUAL SOLICITATION BROCHURE. THE BREAKOUT OF PROPOSALS RECEIVED, SELECTED AND ASSOCIATED FUNDING LEVELS FOR PHASE I AWARDS WERE ALSO SHOWN IN TABLE II.

ADDITIONAL FY 1984 DOLLARS IN THE AMOUNT OF $21.786 MILLION WERE USED FOR FIRST-YEAR FUNDING OF 115 PHASE II PROJECTS FROM THE FY 1983 PROGRAM. DOD ALSO AWARDED $3.062 MILLION TO PHASE II

DESAT PROJECTS MAKING TOTAL FOR ALL PHASE I AND PHASE II AWARDS IN FY 1984 AMOUNT TO $44.584 MILLION. TOTAL PHASE II AWARDS RESULTING FROM THE FY 1984 PHASE I AWARDS ARE EXPECTED TO REACH 150, WITH FIRST-YEAR FUNDING TO COME FROM THE FY 1985 AND FY 1986 SBIR BUDGETS.

IN FY 1985 THE DOD REQUIREMENT FOR FUNDING THE SBIR PROGRAM INCREASED TO 0.5 PERCENT ($79M) OF ITS EXTRAMURAL RESEARCH AND DEVELOPMENT BUDGET ($16.276B). THE STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO) JOINED THE SERVICES, DARPA, AND DNA IN ANNOUNCING 509 TOPICS IN THE ANNUAL SOLICITATION BROCHURE. TABLE II REFLECTS THE PROPOSALS RECEIVED, AND THE PHASE I AWARDS MADE. IN ADDITION, THE DOD IS FUNDING 270 PHASE II PROJECTS FROM THE FY 1983 AND FY 1984 PROGRAMS WITH $48.3 MILLION. THE DOD ALSO AWARDED $1.9 MILLION TO PHASE II DESAT PROJECTS.

THE SBIR PROGRAM HAS COME A LONG WAY SINCE THE EARLY DAYS OF THE DESAT PROGRAM IN DOD. WE ARE ENTHUSIASTIC ABOUT THE PROGRAM AND FEEL IT HAS BEEN OF REAL BENEFIT TO DOD, WHILE ALSO PROVIDING VALUABLE NEW OPPORTUNITIES FOR SMALL BUSINESS. TO MAXIMIZE THESE OPPORTUNITIES THE DEFENSE TECHNICAL INFORMATION CENTER HAS GREATLY ASSISTED BY PROVIDING TIMELY AND RELEVANT TECHNICAL INFORMATION TO POTENTIAL SBIR BIDDERS.

THE DOD HAS LONG BEEN SENSITIVE TO THE NEEDS OF SMALL BUSINESS. THE VOLUNTARY DESAT PROGRAM THAT PRECEDED THE SBIR ACT IS AN EXAMPLE OF DOD EARLY ACTIVITY TO INCREASE THE PARTICIPATION OF SMALL R&D FIRMS OF THIS NATION IN THE INNOVATIVE PROCESS. IT IS OUR VIEW THAT THE CURRENT ACT IS FUNDAMENTALY SOUND, IS WORKING WELL, AND SHOULD CONTINUE FOR THE IMMEDIATE FUTURE.

MR. CHAIRMAN, WE APPRECIATE THE OPPORTUNITY TO TESTIFY ON THE SMALL BUSINESS INNOVATION DEVELOPMENT PROGRAM. WE ARE PROUD OF WHAT DOD AND ITS SMALL BUSINESS CONTRACTORS HAVE ACCOMPLISHED BY WORKING TOGETHER IN ALMOST SIX YEARS OF SBIR AND DESAT PROGRAMS.

- THANK YOU -

Senator Rudman. Thank you very much, Dr. Young.

Dr. Young, is your background technical?

Dr. Young. Yes. I have a Ph.D. in electronics.

Senator Rudman. In electronics. Well, based on that, let me just ask you this general question because, obviously, you probably have a better view of the proposals and the awards that were made.

Tell us, if you can—characterize the level of competence, the level of engineering ingenuity and practicality, if you will, the substance of those proposals which received awards.

Dr. Young. I think the quality of the proposals received has improved quite a bit since the program started. In the early days, we felt that the proposers, the bidders, required some help. As a result of this, we set up a special assistance program under DTIC, the Defense Technical Information Center. When somebody responds to our brochure and says, We are interested in this particular aspect, then we have packages ready to mail to them from DTIC. There were 760 solicitations and 760 different packages that were ready for mailing as soon as somebody wrote in and said they were interested. In this way we improved the quality of the proposals coming in considerably.

Senator Rudman. How about the quality of the work that was done under the phase I and phase II awards?

Dr. Young. In general, the quality is high. I think small business people are highly motivated. They live in the present, and they know what is needed, and so they combine this interesting combination of technical competence and innovative ability which is hard to get in the less immediate needs of a bureaucracy or a university.

Senator Rudman. Well, I asked the question because I have knowledge of some of the proposals and some that have been accepted, and it is my impression that, in some of them, at least, considering the size of the companies and entrepreneurial units, which would be a more proper description of some that had received these awards and had done the work, that it was remarkable in many ways as to some of the innovation and some of the ideas that came in in direct response to DOD criteria and requests. Would you agree with that?

Dr. Young. I agree completely. I think the potential existed all the time. All we had to do was bring it out.

Senator Rudman. Did you find that there were a number of proposals that you might have preferred to have the money to fund that you could not fund because of the limitations of the money available?

Dr. Young. I think this is getting to be more true now. It is very hard to say. In the early days, I think, the first go-around, we funded something like 1 in 10. Now it is getting to be more like 1 in 6.

Senator Rudman. We have a small problem that you are aware of, and I would say in no accusatory way that it appears that the Department of Defense is keeping two sets of books, at least in this area. [Laughter.]

AVAILABLE

Serving on the Defense Appropriations Subcommittee, I sometimes think DOD has two sets of books for everything, but we are only concerned about so-called title 6 funds, 6.1 through 6.6.

It is our understanding, and I think corroborated by GAO, that there is a dispute there, the dispute from the fact that you call 6.6 funds operational systems development and thereby think that they should properly be excluded from the base of calculation. GAO and, I guess, our staff tend to disagree, thinking that you ought to label it as it is requested. What do you say to that, Dr. Young, because we are going to have to straighten this one out, and we want to do it in a sensible, realistic way without doing anything we ought not to be doing.

Dr. YOUNG. I think you have stated it very well.

Senator RUDMAN. About the two sets of books, you mean?

[Laughter.]

Dr. YOUNG. Oh, no, no, with one exception. We do present it in two different ways, and that is certainly confusing. I had hoped to have somebody here from the Office of the Comptroller, and he came early this morning but he had to go back, so let me do the best I can in this rather intricate subject.

Senator RUDMAN. Well, let me say that you do that, but I am now going to ask you, for the record, to supply a very complete answer to this question. I would like you to comment on it now, but for the record, I would like a detailed, complete answer.

Dr. YOUNG. Fine.

Senator RUDMAN. And then I would like to give copies of that to our staff, to the GAO people who did the work, and see if we can sit down and discuss this in a reasonable way.

Dr. YOUNG. I appreciate that very much.

[Subsequent information was received and follows:]

LOWELL WEICKER, JR., CONNECTICUT, CHAIRMAN
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United States Senate
COMMITTEE ON SMALL BUSINESS
WASHINGTON, DC 20510

May 7, 1986

Dr. Leo Young
Chairman
Small Business Innovation
  Research Program
Pentagon
Washington, D.C. 20301

Dear Dr. Young:

We would like to extend our thanks for testifying at the Senate Small Business Committee's March 11, 1986 hearing on the Small Business Innovation and Research Program, P.L. 97-219. Your written statement and your oral testimony will be very helpful to the Members of the Committee.

Due to the time constraints of the hearing, several important points raised by your written statement and oral testimony were not fully explored. In order to make the hearing record complete, the Committee would greatly appreciate it if you would provide a written response to the attached question, which will be included in the hearing record. We would appreciate this response no later than one week from the date of receipt of this letter. As soon as the transcript is printed, you will receive a copy.

Your response should be directed to the Committee on Small Business, United States Senate, Room 428A Russell Senate Office Building, Washington, D.C. 20510, to the attention of Tracy Crowley, Hearing Clerk.

Again, thank you for your participation at this important Committee hearing and for promptly furnishing the response to our question for the record.

Sincerely,

Warren B. Rudman
WARREN B. RUDMAN
United States Senator

LOWELL WEICKER, Jr.
Chairman

Enclosure

QUESTION FOR THE DEPARTMENT OF DEFENSE

1. The House Small Business Committee requested the Comptroller General to rule on whether or not the funds appropriated to DOD under category 6.6. "Operational Systems Development" are within the statutory definition of R&D for purposes of calculating its SBIR budget. Please give a detailed explanation as to why DOD officials believe the funds appropriated under 6.6 should be excluded from the agency's extramural budget?

RESEARCH AND
ENGINEERING

OFFICE OF THE UNDER SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301-3000

21 MAY 1986

Honorable Lowell Weicker, Jr.
Chairman, Committee on Small Business
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

This is in response to your letter of May 7, 1986, in which you asked for a detailed explanation as to why Department of Defense officials believe the funds appropriated under 6.6 (Operational Systems Development) should be excluded from the Agency's extramural budget used as baseline for the Defense Small Business Innovation Research Program (SBIR). I am pleased to provide an explanation of the DoD position in this matter.

Those within the Department of Defense that are responsible for implementing the program concluded that to include the 6.6 funds would be counter-productive to the purpose of the Act. The 6.6 category of the RDT&E budget was established to address the need either to correct deficiencies in fully developed and fielded weapons systems, or to change the performance characteristics of those systems based on changed requirements. In both cases, the funds go to the specific contractors that developed the baseline system and components and, consequently they do not afford new opportunities for the small businesses that are the target of the SBIR program. The result of inclusion of the large 6.6 category, therefore, is to impose a proportionately heavier burden on the other categories to support the program, a result that appears contrary to the Congressional intent evidenced by the statement in the Senate Report accompanying S. 881:

> However, the Committee expects agencies to exercise this discretion in a manner that will not result in the disproportionate taxing of any single area of research. For example, there has been concern expressed that basic research in particular may, in some instances, be required to bear a greater share of the burden of funding SBIR programs. It is the Committee's intent that this not occur. The Committee believes that the funding of SBIR programs can be done without jeopardizing any of the research now being conducted. (S. Rep. No. 194, 97th Cong., 1st Sess. 11 (1981).)

These results motivate managers to look for formulations that will give rise to what they perceive to be a more realistic and responsive application of the scarce research budget. Since the inclusion of the 6.6 funds seems to be counter-productive to the purposes of the statute, it would appear that the solution is to amend the Act to include within the "extramural budget" only those research or research and development funds that in fact could be used for possible contracts with small business.

I trust that this explanation is responsive to your inquiry. A similar letter was sent to Senator Rudman.

Sincerely,

Leo Young

Leo Young
Director, Research and
Laboratory Management

Dr. YOUNG. The decision to fund out of program 6.1 through 6.5 excluding the 6.6 was not taken lightly, and it was done after considerable consultations with OMB and within DOD.

Let me try to explain what 6.6 means to us and where the problem exists if I can.

Senator RUDMAN. All right.

Dr. YOUNG. The RDT&E account, as we call it—research, development, test and evaluation—finances R&D efforts that go all the way from basic research to modifying systems in production.

We place R&D on systems not ready for production in what we call budget category 6, which goes from 6.1 through 6.5; whereas R&D systems that are already in production, or at least approved for production, those funds are accumulated in a category we call operational systems development. They are reported along with the RDT&E Program, and so they have popularly become known as 6.6.

For purposes of the 5-year development plan, we arrange the budget by mission area. One mission is R&D. We report the 6.6 part, which funds produce improvement of systems in production or approved for production. We place that with the rest of program 6 in the totality of RDT&E.

Let me give you an example. Supposing that the F-14 fighter plane required an upgrade on its radar system.

The radar is already on the plane, it is already flying, but maybe the receiver could be improved. The radar is built by Hughes. We would provide funds to Hughes to improve the receiver, in their radar, and place it on the B version or C version of the airplane.

Or the A-6 plane, let us say, might develop cracks in the wings. What do you do to fix it? You go to Grumman, the manufacturer, and say, Here are some 6.6 funds to fix those wings.

Senator RUDMAN. I think I understand it. I think the problem may be strictly a bookkeeping problem. I spoke to, and the staff spoke to, the staff over at our Defense Appropriations Committee. Of course, you do not break it out that way. That is not to say you do not keep it that way internally.

I guess your argument is that if you have got, I think, this year $10 billion to $11 billion in the 6.6 category, and that is for essentially working on systems that already exist to either improve them in terms of reliability or maintainability or performance, that you really should not have that in your base because that is going to skew the numbers to some extent, because there is no way whatsoever that you are in any position to use any of that money for the purposes of this act, so you are going to have to take a larger piece from another portion. Do I state the case?

Dr. YOUNG. Yes, exactly.

Senator RUDMAN. All right. I think I understand it, and I think it is a problem.

Dr. YOUNG. Senator Rudman, there was a letter sent by the Comptroller General very recently, February 21, to the House Committee on Small Business, and this is how it concluded. It was a three-page letter. This comes after the GAO report that Ms. Frazier discussed. This is what it says:

'The Committee on Small Business may wish to consider whether category 6.6 should be exempted from the act because of the practical difficulties," that is to say in funding the SBIR Program out of that category.

Senator RUDMAN. Well, we went through the same kind of discussion back at the time of the act with NASA, and so I think we are familiar with it.

Well, I thank you very much, and we may expand on the questions on this matter.

Dr. YOUNG. I will be glad to.

Senator RUDMAN. The other problem that we have had—and I address this not to any of the witnesses but just for the record—has to do with NIH, and I wish at this point to insert in the record a statement concerning NIH.

[National Institute of Health statement follows:]

NATIONAL INSTITUTE OF HEALTH STATEMENT

The Committee notes that the NIH Small Business Innovation Research Program (SBIR) maintains the second largest budget mandated by Public Law 97-219. The Committee is aware of the concerns expressed by the Small Business Administration and small firms participating in the program with respect to NIH's implementation of Public Law 97-219. While NIH has improved its efforts in this regard, still greater achievement can be expected as NIH continues to build relationships with the community of research-oriented small businesses and to define SBIR procedure. The Committee expects that the Director will provide strong central management and representation for the SBIR Program and the Director will be responsible for ensuring that special emphasis be given to the following objectives: (1) SBIR applicants are to be notified of funding decisions within 6 months of each receipt date for SBIR proposals; (2) small business proposals of the highest quality are funded by moneys set aside for the SBIR Program by adjusting the distribution of grant applications to the maximum extent possible; and (3) NIH ensures uniform SBIR administrative practices across the participating awarding units. The Committee directs that these objectives be realized during the 1986 fiscal year.

Senator **Rudman**. It well may be, because of the special nature of NIH, that we may want to have a separate hearing just on NIH.

I want to thank you. Mr. Crouch, I want to thank you for being here. I want to thank all of the witnesses for their testimony. We are building a record starting in New Hampshire last week where we had our first hearing. Because of the enormous amount of activity in innovation and technology in Massachusetts and New Hampshire, we had a number of witnesses from those two States, and we had this hearing. We will have others. We will probably have other field hearings.

What we want to do is, in a good-faith way, see what can be done to improve the act, if anything, whether or not there ought to be exemptions granted, which we obviously are very hesitant to do. I am getting even more nervous about exemptions since my experience on an obscure bill known as Gramm-Rudman-Hollings. [Laughter.]

So, you know, sometimes exemptions are big enough to put a credit card through, and sometimes they are big enough to drive an M-1 Abrams through, and we want to make sure that it is the former, not the latter, or else the very purpose of this act could be hindered.

So we appreciate your being here. I thank you all for coming here this morning, and I apologize for the delay.

The committee stands in recess.

[Whereupon, at 12:15 p.m., the subcommittee adjourned subject to the call of the Chair.]

APPENDIX

NATIONAL INSTITUTE OF HEALTH STATEMENT

The Committee notes that the NIH Small Business Innovation Research Program (SBIR) maintains the second largest budget mandated by Public Law 97-219. The Committee is aware of the concerns expressed by the Small Business Administration and small firms participating in the program with respect to NIH's implementation of Public Law 97-219. While NIH has improved its efforts in this regard, still greater achievement can be expected as NIH continues to build relationships with the community of research-oriented small businesses and to define SBIR procedure. The Committee expects that the Director will provide strong central management and representation for the SBIR Program and the Director will be responsible for ensuring that special emphasis be given to the following objectives: (1) SBIR applicants are to be notified of funding decisions within 6 months of each receipt date for SBIR proposals; (2) small business proposals of the highest quality are funded by moneys set aside for the SBIR Program by adjusting the distribution of grant applications to the maximum extent possible; and (3) NIH ensures uniform SBIR administrative practices across the participating awarding units. The Committee directs that these objectives be realized during the 1986 fiscal year.

STATEMENT FOR THE RECORD
U.S. ENVIRONMENTAL PROTECTION AGENCY
TO THE
SUBCOMMITTEE ON INNOVATION AND TECHNOLOGY
COMMITTEE ON SMALL BUSINESS
UNITED STATES SENATE

March 11, 1986

Mr. Chairman and members of the Subcommittee. This constitutes the Environmental Protection Agency's (EPA) statement for your Subcommittee's oversight hearing on the Small Business Innovation Research (SBIR) Program.

We thank you for this opportunity to apprise you of our SBIR Program. In general, we believe that this program has been a success and that there have been no major problems implementing the requirements of the Small Business Innovative Development Act of 1982 (P.L. 97-219) by EPA.

Financial Accounting for the SBIR Program

This Act mandates that a specific percentage of our extramural budget be set aside for our SBIR program. This program has been administered by EPA's Office of Exploratory Research since FY 1983. Our SBIR Program has been funded at the following levels:

EPA SBIR PROGRAM

Fiscal Year	Extramural R&D Budget	Mandated SBIR Percentage	Required SBIR Funding	Actual SBIR Funding
1983	$121,000,000	0.2%	$ 242,000	$ 248,000
1984	$145,700,000	0.6%	$ 874,200	$ 852,717
1985	$188,900,000	1.0%	$1,889,000	$1,860,360
1986	$232,100,000 1/	1.25%	$2,901,250	$2,587,800 2/

1/ Includes Superfund and AC&C Extramural Funds

2/ Amount Reprogrammed to Date Reflects R&D Appropriation Only

We have published three Phase I solicitations and two phase II solicitations, beginning with FY 1983 and including FY 1985.

Request for Solicitations

FY 1983 - The Phase I solicitation generated 214 proposals, and we made 10 awards.

FY 1984 - The Phase I solicitation generated 136 proposals, and we made 10 awards. We solicited from our 1983 Phase I awardees a Phase II application, and we received eight responses. Of those eight, the Program awarded five Phase II projects.

FY 1985 - The Phase I solicitation generated 154 proposals, and we made 20 awards. We solicited from our 1984 Phase I awardees a Phase II application, and all ten responded. Of those ten, the Program awarded six Phase II projects.

The maximum allowed funding level for each of our Phase I and Phase II awards per fiscal year is as follows:

FY 1983 - Phase I $25,000
FY 1984 - Phase I $35,620; Phase II $100,000
FY 1985 - Phase I $48,500; Phase II $150,000

Nature of Awards

SBIR funds are awarded in the following research areas:

1. engineering projects to control or lessen pollution;
2. engineering projects to convert waste products into useful by-products; and
3. instrumentation of use to EPA.

We presently have one follow-on (Phase III) private sector funding commitment made for a Phase II proposal. This company, Bend Research of Bend, Oregon, has developed an economical energy-efficient process for the recovery of certain metal values in a usable form from pollution control sludges generated by electroplating and electronics industries.

We are very pleased with the response we have received from our SBIR program and believe that an excellent return on investment will be obtained as the projects mature.

Implementation

In FY 1983 through FY 1985, EPA based its SBIR allocation on its Research and Development appropriation only. Following a review last year by the General Accounting Office, EPA has determined that its SBIR Program should be based on a percentage of its entire extramural research budget, which includes extramural object classes in its Superfund and its Abatement, Compliance and Control (AC&C) appropriations. Beginning in FY 1986, EPA will increase its SBIR allocation to reflect the entire Agency extramural research budget.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

March 10, 1986

Honorable Lowell Weicker, Jr.
Chairman, Committee on Small Business
United States Senate
Washington, D.C. 20510

Dear Senator Weicker:

Thank you for your invitation of February 26 to submit for the record the views of the Department of the Interior (DOI) on the Small Business Innovation Research (SBIR) Program, P.L. 97-219.

The SBIR program can serve as a unique tool in identifying research that can be of significant benefit. The program allows agencies to "sample" innovative ideas during Phase I without expending large sums of money; then, if feasible, continue into Phase II with further support.

DOI's extramural research budget for FY 1984 was $76,465,000. We issued one Phase I solicitation which yielded 110 proposals. From those proposals, DOI awarded 13 Phase I contracts for a total of $418,916. We also received four Phase II proposals of which two contracts were awarded for a total of $386,842. There were no follow-on funding commitments.

In FY 1985 our extramural research budget is estimated to be $71,715,000. Our Phase I solicitation was issued and we received 72 proposals. From those proposals, two contracts were awarded for a total of $63,359. Nine Phase II proposals were also received and one Phase II contract was awarded for $150,000 with no follow-on funding commitment.

The funding level for Phase I contracts is limited to $35,000 and Phase II contracts is limited to $250,000.

As you can see from the above, DOI's extramural budget has fallen well below the threshold level of $100 million required to participate in the SBIR program. While we feel that SBIR is a good program, the Department of the Interior, unlike other Departments which require outside research to supplement their research programs, has a limited need for these types of supplemental projects. This limited need only serves to frustrate potential contractors who expend their time and money on proposal preparation. Therefore, DOI is not continuing its participation in the SBIR program in FY 1986.

We would be pleased to provide to the Committee and its staff any additional information which would be helpful in your further consideration of the SBIR Program.

The Office of Management and Budget has advised that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely,

Joseph P. Riordan Jr.

Deputy Assistant Secretary for
Water and Science

SUMMARY OF THE SMALL BUSINESS INNOVATION RESEARCH PROGRAM

SUBMITTED BY

UNITED STATES NUCLEAR REGULATORY COMMISSION

STATEMENT FOR THE RECORD

TO THE

SUBCOMMITTEE ON INNOVATION AND TECHNOLOGY
COMMITTEE ON SMALL BUSINESS
UNITED STATES SENATE

SUBMITTED: MARCH 6, 1986

Statement submitted for March 11, 1986 oversight hearing on the Small Business Innovation and Research (SBIR) Program, P.L. 97-219.

The following is an overview of the NRC's SBIR program for both FY 1984 and 1985. This program is administered by the NRC Office of Nuclear Regulatory Research (RES).

- The RES extramural R&D budget was:

FY 1984	FY 1985
$172,896,000	$132,982,000

- The amount set aside for small businesses was:

FY 1984	FY 1985
$1,037,376	$1,329,820

- RES has issued one SBIR solicitation per year for Phase I and Phase II since the program began in 1983.

- The number of proposals received in response to SBIR solicitations was:

	Phase I	Phase II
FY 1984	110	7
FY 1985	72	5

o THE NUMBER OF CONTRACT AWARDS MADE FROM PROPOSALS SUBMITTED WAS:

	PHASE I	PHASE II
FY 1984	6	4
FY 1985	10	4

o THE AVERAGE FUNDING LEVEL OF THE CONTRACT AWARDS MADE WAS:

	PHASE I	PHASE II
FY 1984	$44,500	$219,000
FY 1985	$47,500	$213,000

o THE TOTAL AMOUNT OF FUNDS EXPENDED IN BOTH FY 84 AND 85 WAS:

FY 84	$1,144,037
FY 85	1,333,140
TOTAL	$2,477,177

o OF THE EIGHT(8) SBIR PHASE II CONTRACT AWARDS, RES IS NOT AWARE OF ANY FOLLOW-ON FUNDING COMMITMENTS.

- THE NRC SBIR PROGRAM IS A SMALL PROGRAM WITH ONLY A TOTAL OF EIGHT(8) PHASE II CONTRACTS AWARDED TO DATE. OF THE FOUR(4) CONTRACTS AWARDED IN FY 1984, THREE OF THESE HAVE RECENTLY COMPLETED WORK AND THE FOURTH IS SCHEDULED FOR COMPLETION IN THE NEAR FUTURE. THE FY 1985 PHASE II CONTRACTS WILL NOT BE COMPLETED UNTIL LATE 1986 OR 1987. PRELIMINARY INDICATIONS ARE THAT THE WORK PERFORMED UNDER THE SBIR CONTRACTS IS WORTHWHILE. HOWEVER, RES HAS NOT YET MADE AN INDEPTH EVALUATION OF THE RECENTLY COMPLETED WORK AND IS THEREFORE UNABLE TO PROVIDE AN ACCURATE ASSESSMENT OF THE PROGRAM AT THIS TIME.

- WITH RESPECT TO IMPLEMENTATION OF THE PROGRAM, RES HAS NOT EXPERIENCED ANY PROBLEMS.

STATEMENT FOR THE RECORD
OF JON SEYMOUR
ASSISTANT SECRETARY FOR ADMINISTRATION
DEPARTMENT OF TRANSPORTATION
BEFORE THE SENATE COMMITTEE ON SMALL BUSINESS
REGARDING THE SMALL BUSINES INNOVATION RESEARCH PROGRAM

MARCH 10, 1986

The U.S. Department of Transportation (DOT) has established a Small Business Innovation Research Program, (referred to as the DOT SBIR Program) which is administered through our Research and Special Programs Administration. It was established pursuant to the Small Business Innovation Development Act of 1982 (PL97-219).

Overview:

- We believe that is too early to predict the outcome of the various SBIR projects undertaken to date because the three phases of the SBIR cycle have not been completed for any of our projects. However, a number of R&D projects appear promising for commercialization.

- The program utilizes many small business contractors that would not normally be able to successfully compete for larger DOT research work.

- We believe that the overall coordination of agency programs under the leadership of Small Business Administration (SBA) has been good. Our experience indicates the small business community knows about the program and is interested in competing for Government business.

Experience:

- Over the past few years we have had a disagreement with SBA over how our extramural R&D budget should be established for the purposes of the Act, but this issue has been resolved. Other agencies had similar problems.

- Many of our technical managers who work with the SBIR program believe that the program is a simple, effective way to reach a broad cross-section of the small business research community that would not usually compete for DOT programs.

- In general, we believe that the program is meeting its objectives, and are looking forward to the commercialization of some of the projects for which we have funded the initial stages.

Our statistics on the DOT SBIR program which you requested are set forth in the Attachment. We will be happy to provide any additional information you may need.

Attachment

	1984	1985
DOT's extramural R&D Budget	$272,400,800	$308,200,000
DOT's extramural R&D Budget set-aside for small business	$1,677,006	$3,162,339
Number of R&D solicitations published for Phase I and Phase II	1	1
Number of Proposals Generated for: Phase I	366	318
Phase II	6	16
Actual Number of Awards made for: Phase I	17	30
Phase II	3	6
Funding level of awards for:		
Phase I	$812,785	$1,481,019
Phase II	$864,221	$1,681,320
Funds expended	$1,677,006	$3,162,339
Follow on funding commitments for Phase II proposals	4	7

NATIONAL SCIENCE FOUNDATION
WASHINGTON D.C. 20550

nsf

OFFICE OF THE
DIRECTOR

March 18, 1986

Honorable Warren B. Rudman
Chairman
Subcommittee on Innovation and Technology
Committee on Small Business
United States Senate
Washington, DC 20510

Dear Senator Rudman:

I am pleased to respond to your request for a written statement for the record of your March 11, 1986 subcommittee hearing on oversight of the Small Business Innovation Research (SBIR) program, P.L. 97-219.

Introduction

Small high technology firms represent an important national resource to the United States. They have strong research capabilities and accelerate technological innovation. They represent one of the best mechanisms to convert research into technology and commercial products. Finally, they provide a major avenue for applying NSF research for economic and social benefits to our nation.

NSF Role in Development of the SBIR Program

We are proud of the original design and early experimental role played by the National Science Foundation leading to the passage of the Small Business Innovation Development Act of 1982, P.L. 97-219 and expanded to other agencies. The program is carried out in three phases: Phase I explores the feasibility of the proposed concept; Phase II is the principal research stage; and Phase III is the product development and commercialization stage. The SBIR program provides a major opportunity for science and technology-based small firms to participate in NSF research programs. It enables them to propose long term, high risk creative ideas that could only be pursued with outside support. In addition, NSF SBIR awards have provided the basis which has helped the firms to attract private investment, obtain other R&D awards, and develop working arrangements with State and local government agencies, universities, venture capital and large industrial firms.

The Small Business Innovation Research program was developed at NSF in Fiscal Year 1977 when Congress directed the NSF to award $1 million of applied research funds to small business firms. The program will grow to a level of $17.15 million in Fiscal Year 1987 due to the legislative requirements of P.L. 97-219. The legislation prescribes that 1.25 percent of the Foundation's extramural research budget be reserved for awards to small business concerns through a uniform process. Since the initiation of the SBIR program at NSF in Fiscal Year 1977, NSF has cumulatively made $41.6 million available to support the highest quality research proposals received under the annual SBIR Program Solicitations.

NSF has issued eight SBIR program solicitations--1977, and 1979 through 1985. These solicitations generated a total of 5,826 Phase I proposals from which NSF has made a total of 686 Phase I awards and 216 Phase II awards.

Current SBIR Activity at NSF

The SBIR program resource allocations for Fiscal Years 1984 and 1985 were $7.1 million and $12.4 million based on NSF's estimated extramural research budgets of $1,089.4 million and $1,247.3 million respectively. In Fiscal Year 1984, the NSF made 102 Phase I awards out of 1185 proposals submitted. In Fiscal Year 1984, NSF made 53 Phase II awards, which included 34 new awards and 19 continuing grant actions. These Phase II awards were drawn from 81 proposals received under previous solicitation.

In Fiscal Year 1985, the Foundation made 105 Phase I awards out of 977 proposals submitted. In Fiscal Year 1985, NSF made 64 Phase II awards, which included 33 new awards and 31 continuing grant actions. These Phase II awards were drawn from 126 proposals received under previous solicitations.

NSF SBIR Solicitation Design

The NSF Solicitation was designed to provide incentives for the conversion of Federally sponsored research to technological innovation in the private sector. This research can serve as both a technical and pre-venture capital base for ideas which might have commercial potential.

The NSF SBIR solicitation is designed to permit the proposing small high tech firm to target its research proposals on advanced concepts which will advance the scientific and engineering objectives of the Foundation, particularly where the research may serve as a base for technological innovation. The next solicitation which will be issued in April 1986, contains topics from the 21 disciplinary research divisions and the Office of Advanced Scientific Computing. Additional emphasis in this solicitation is focussed to stimulate high quality research in four areas of growing national importance: biotechnology, scientific instrumentation, supercomputing, and manufacturing systems. This new solicitation allows the firms to compete in all research areas generally supported by the NSF.

Proposers are asked to consider whether the research they are planning has commercial possibilities for the proposed application or as a base for other applications. If their research has such potential, they are encouraged to obtain contingent commitments for non-federal, follow-on funding from a third party, preferably private. This allows them to pursue further development of the commercial potential after the Government funding pays for research on Federal objectives (Phases I and II). Non-federal funding pays for development for commercial objectives in Phase III.

NSF Experience with Follow-on Funding Commitments

The commitment for follow-on venture capital or other funding is obtained from a party of the proposer's choice. It is understood that the commitment will be contingent upon the research achieving certain technical objectives mutually agreed upon between the small business and the provider of the follow-on capital. At NSF, the commitments to date have taken the form of venture capital, contract R&D, joint ventures, R&D limited partnerships, or other agreement with a third party or combination thereof. Our SBIR Program Officers work closely with the Principal Investigators to maximize the conversion of the science developed in the research effort into technology. In Fiscal Years 1984 and 1985, 40 out of 53 and 60 out of 64 Phase II awards respectively had acceptable follow-on funding commitments. During the first four solicitation years of the program at NSF, the $18.4 million of Federal funds expended were matched by private sector follow-on funding amounting to $149.5 million. This is a leveraging factor of 8:1 of private sector to Federal funds.

Significant Examples of Converting Government and University Bioscience into Industrial Pay-offs

o In 1977, NSF funded a Phase I genetics research proposal from Collaborative Research, Inc. in Waltham, MA. The company president, Dr. Orrie Friedman, had been a professor at Brandeis University. Although the origin of the non-medical genetics idea was initiated at the Harvard

Medical School, the medical school decided not to pursue it. NSF made awards of $25,000 in Phase I and a $239,000 in Phase II to conduct research on Enhancement of Animal Protein Production by Novel Genetic Technology. Dow Chemical was interested in this type of research and found Collaborative Research through abstracts of NSF SBIR awards. Dow subsequently invested $11.5 million in the SBIR firm. Collaborative Research, Inc. had 33 people at the time of the Phase I award and relatively old facilities. Today, the firm has 135 employees and large new laboratories in Lexington, MA. It has also gone through two very successful public offerings and is a leader in the biotechnology field. It has raised over $40 million based on the initial genetics research conducted under the 1977 NSF SBIR award.

o Native Plants, Inc. of Salt Lake City, UT received a Phase I award for research on a Mycorrhizal Innoculated Containerized Plant Growing System in 1980. The company had 45 employees and received a $30,000 Phase I and related $200,000 Phase II award. It had a Phase III commitment of an equal amount from a Chicago based venture capital firm--F.H. Prince and Company. The research was highly successful and $1 million of private funds were invested in the project. This and other SBIR awards helped the company obtain an additional $39 million of private investment in the form of seven R&D Limited Partnerships and investments by five large industrial firms. The company now has 250 employees and outstanding new laboratories in a research park adjacent to the University of Utah campus.

o Verax Corporation of Hanover, NH received a Phase I award of $35,000 in 1982 for research on Long-life Catalysts for Immobilized Microorganism Fermentors. Much of the original idea came from Professor Venkatasubramanian of Rutgers working with Dr. Robert Dean, President of Verax and Principal Investigator. Four other Dartmouth professors in biochemistry, biophysics, microbiology, and chemical engineering were involved as consultants. Early work was carried out in Dartmouth laboratories leased by Verax using students as part-time employees. The Phase I research was very successful and the fermentation process has been speeded up by a factor of 10 as a result. Verax then obtained a follow-on funding commitment and already has received more than $3 million in new investment. It also has a new laboratory, is working closely with MIT as well as Dartmouth and Rutgers scientists and is already selling products to major biological and pharmaceutical firms. Verax grew quickly from four to 110 employees and spun-off two separately financed scientific instrument firms, one in biotechnology and the other in medical instrumentation. These spin-offs are direct by-products of the NSF and NIH SBIR projects. Verax continues to have 60 employees after the two spin-offs.

Program Assessment

These examples represent only a few of the many successful collaborations between the Federal Government, small high tech firms, universities, large industrial and venture capital firms. We are convinced the program is working as intended. SBIR was designed to provide full value to the government for the R&D funded with small firms. We believe that SBIR firms may do better than other performers of Federal R&D in terms of value received due to the unique capabilities of entrepreneurial and innovative small high tech firms who conduct R&D at lower cost. This is in part due to the extremely competitive nature of the program imposed by the limited funding and high visibility of the program.

Recommendations for Enhancement of Program Administration

While the SBIR program has been a success at the NSF, we believe that the program could be improved if we could be allowed to use a limited amount of the SBIR research funds for administration of the program. These additional resources are needed to pay for: (1) the printing and mailing costs of the annual SBIR program solicitation and abstracts publication which are required for successful implementation of the Act; (2) the costs of supporting the two highly successful annual High Tech Conferences which bring together, in a central location, the potential small high tech researchers with SBIR managers of all of the participating Federal agencies, representatives of major prime contractors, venture capital personnel, and State and local Government representatives; (3) the costs of developing a small "out-reach" effort to foster and encourage greater participation by minority and disadvantaged persons in technological innovation, and (4) costs associated with the peer review panels which provide our Program Officers with the critical advice and input to technically evaluate the broad spectrum of proposals submitted in response to the annual solicitation. These expenditures approximate $150,000 per year and would continue to allow us to maintain the momentum of this highly successful endeavor. This practice is followed by most of the programs throughout the Foundation; and therefore, SBIR would benefit from such treatment.

Conclusion

SBIR is funding cutting edge research in key high risk areas that often only the government can support. It is an opportunity for researchers with high risk ideas from small firms with strong R&D capabilities to work effectively with universities, industry and venture capital firms to promote the economic competitiveness and technological innovation that for so long has been the backbone of our industrial capabilities.

I would be pleased to respond for the record to any questions which the members of the committee might have.

Sincerely,

Erich Bloch
Director

Statement

of

William J. Bennett

Secretary of Education

U.S. Department of Education

for

SENATE SMALL BUSINESS COMMITTEE

U.S. Senate

Washington, DC

March, 1986

Mr. Chairman and Members of the Committee:

It is with some satisfaction that I report to you on the first three years of the Small Business Innovation and Research (SBIR) program in the Department of Education. The purpose of the program is to provide funding to small businesses to develop innovative ways to improve American education. This year, about $1.47 million will be awarded.

The Small Business Innovation Development Act, P.L. 97-219, was signed by President Reagan in August 1982 and was further supported by a memorandum from the President to agency heads in September 1982.

The Act is based on the premise that small firms can conduct research and development activities efficiently and are especially effective in marketing new products. It requires every Federal agency with an extramural research and development budget exceeding $100 million to set aside a percentage of that budget--1.25% for each fiscal year 1986 through 1988--for a special competition limited to small, profit-making firms, to conduct research and development of interest to the particular agency.

The statute sets forth three phases for the program: (1) determining the scientific and technical merit and feasibility of ideas submitted pursuant to SBIR program solicitations, (2) researching and developing the proposed ideas to meet the particular program needs, and (3) developing commercial applications of the research and development which may also involve non-SBIR Federal funding.

The Department of Education is one of twelve Federal agencies participating in the SBIR program. Four organizational components in the Department have been the prime contributors to the program: The Office of Special Education and Rehabilitation Services, the Office of Educational Research and Improvement, the Office of Bilingual Education and Minority Language Affairs, and the Office of Postsecondary Education. Each Office contributes by setting aside resources, identifying topics for the Phase I solicitation, reviewing and rating proposals, selecting awardees and monitoring the projects.

The Department has successfully operated the SBIR program since it first began in fiscal year 1983. In fact, it has exceeded the legislated set-asides which were 0.2 percent, 0.6 percent, and 1.0 percent respectively for fiscal years 1983, 1984, and 1985. During fiscal year 1983, eight Phase I awards were made from a single solicitation which generated eighty-four proposals. The average award in that first year for Phase I was nearly $39,000 for a six-month period. The Department's extramural research and development budget was $116 million in fiscal year 1983, of which $232,000 was set aside for small business firms. Some $311,000 was actually obligated during that year.

Fiscal year 1984 was the first year in which both Phase I and Phase II awards were made. Thirteen small business firms received awards from a single Phase I solicitation which generated 234 proposals. Three Phase II recipients were chosen from seven applicants which had conducted Phase I projects in 1983. In total, the Department's fiscal year 1984 extramural research and development budget was $111.8 million, of which $671,000 was set aside for small business firms under the SBIR program. For fiscal year 1984, over $964,000 was awarded for Phase I and Phase II, including $270,000 for 1985 costs of Phase II projects, which span two fiscal years. Therefore, fiscal year 1984 obligations totaled $694,000, or $23,000 more than the set aside.

In many ways fiscal year 1985 mirrored fiscal year 1984; that is, thirteen small business firms received awards from a single Phase I solicitation which generated 142 proposals. Additionally, the one Phase II competition during fiscal year 1985 resulted in five awards from eleven proposals received. The Department's extramural research and development budget for fiscal year 1985 was $111.4 million, of which one percent, or $1,114,000, was set aside for small business firms. During fiscal year 1985, a total of nearly $1,376,000 was awarded for Phase I and Phase II competitions and $1,161,000 was obligated, once again reflective of Phase II awards spanning two fiscal years.

A request for proposals has been issued and is now available to small business firms under the Department of Education's fiscal year 1986 Phase I and Phase II SBIR program. The Department's extramural research and development budget is $117.6 million of which 1.25 percent or $1,470,000, has been designated under the provisions of the SBIR program. Within that total, it is estimated that thirteen to fifteen Phase I awards of about $30,000 each and three to five Phase II awards will be executed. Phase II awards will continue to total approximately $200,000 each for the two-year period.

During the first three years of the SBIR program, a dozen topics identified by the Department of Education to small business firms generated a number of promising proposals which are now being supported. For example, projects have been funded that

- help teach the blind to use word processing equipment,
- aid in secondary school science laboratory instruction,
- foster basic skills learning in Hispanic and Latino students, and
- teach Chinese, Japanese, and English languages with graphics, text, and voice capabilities.

Several new topics have recently been introduced to small business firms by the Department in its fiscal year 1986 Phase I solicitation. These include:

- innovative approaches in such areas as learning and instruction at the elementary school level,
- use of technology in communicating research results,
- application of technology to the teaching of uncommonly taught modern foreign languages,
- instruction of adult learners, and
- the assessment of educational outcomes.

To date over 1,700 small business firms from all 50 states, D.C., and Puerto Rico have requested and have been sent a copy of the Phase I solicitation. The Department of Education is accepting Phase I proposals through March 31, 1986, and will make awards during the summer months. We are encouraged by the degree of interest shown by the small business community in our recent solicitation and we look forward to supporting the most promising of the innovations which are proposed.

The Department of Education SBIR program is still relatively new. The first three Phase II awards have just recently been completed. In fact, awardee final reports have not yet been submitted to the Department. Awards under Phase III--commercial applications of products generated through Phase I and II--while promising, have yet to meet the market test. Therefore, the Department has not engaged in an overall evaluation of its SBIR program.

In summary, the Department of Education has complied with the provisions of the Small Business Innovation Development Act. It has exceeded the minimum financial set-asides specified for each year. We are encouraged by and support the Small Business Innovation Research program. We look forward to supporting promising ideas generated by small business firms to improve teaching and learning.

Statement of the Department of Energy

before the

Subcommittee on Innovation and Technology

Small Business Committee

United States Senate

March 11, 1986

Mr. Chairman, the Department of Energy (DOE) is pleased to provide these comments on the DOE Small Business Innovation Research (SBIR) program.

Since our last testimony in March, 1984, the program has matured significantly. We have by now issued four Phase I solicitations, reviewed well over three thousand proposals, selected for funding over three hundred Phase I projects and about one hundred Phase II projects; the first "cycle" of SBIR projects--those initiated for Phase I in FY 1983--is just coming to completion. Thus, while it is still too early to attempt a full evaluation of the SBIR program, this may be a very opportune time to share with the Committee some of our experiences in implementing the program.

HIGH TECHNICAL QUALITY

Perhaps the most striking feature of the DOE SBIR program is the high technical quality of projects supported. DOE technical staff involved in proposal review and selection reports overwhelmingly that the weight of the technical contents of our SBIR projects is fully comparable with that of projects supported by the Department outside of SBIR. Quite obviously, most of our SBIR projects differ in nature, as they should, from work funded at universities and national laboratories; in formulating technical topics for inclusion in an SBIR solicitation, we are mindful of the need to attract projects with a potential of going into Phase III. Even so, comparisons of the degree of complexity, innovativeness and technical sophistication between our SBIR and non-SBIR projects can be made, and SBIR projects fare quite well in such comparisons.

MERGING FUNDS

The attainment of high technical quality of SBIR projects has been made possible by adopting the principle of merging contributions made to SBIR by different Departmental elements--contributions oftentimes derived from different appropriations--into a single SBIR fund. Thus we were able to entice the various technical programs into a healthy competition. By submitting well-designed topics for inclusion in the annual SBIR solicitation, and by publicizing the solicitation within the respective technical communities, the various programs can assure that funds contributed to SBIR will return to the respective programs in the form of SBIR-supported Phase I and Phase II projects.

PROGRAM BALANCE

While technical excellence is clearly the primary consideration in the DOE proposal selection process, we also have in place a mechanism which promotes overall program balance without sacrificing quality. Here the objective is to make the technical spectrum of DOE SBIR projects track as closely as possible the spectrum of Departmental priorities. This is accomplished by making the number of technical topics placed in a solicitation roughly proportional to the respective technical program's contribution to the SBIR fund. Accordingly, there is more opportunity to submit proposals in areas which, by Administration policy and Congressional mandate, require stronger emphasis.

Experience has taught us that excellent SBIR proposals can be encouraged in virtually every field of Departmental technical activity, including such seemingly esoteric technical areas as, for example, high energy particle physics. Managers of that program were able to identify subjects of vital interest to high energy physics which at the same time were most appropriate for SBIR work; examples include innovations in cryogenic technologies, superconducting wire fabrication and accelerator instrumentation. As a result, the high energy physics program, a major contributor to the SBIR program, is getting back the value of its monetary contribution to the SBIR fund in the form of SBIR projects of outstanding quality.

The number of SBIR Phase I proposals has declined from the first-year high of over 1,700 in FY 1983 to approximately 700 in FY 1986. Nevertheless, a thorough technical review of these proposals, conducted within the time constraints mandated by the Small Business Administration (SBA) Policy Directive, requires a highly concentrated effort on the part of many DOE technical staff members. The excellent cooperation on the part of various Departmental elements with the SBIR program provides convincing testimony as to the value of SBIR-selected projects to the DOE technical programs.

SOME VITAL STATISTICS

The accompanying table summarizes some DOE SBIR vital statistics. The following comments pertain to this table:

- The dollar discrepancy in the FY 1985 column, between the line "Amount Set-Aside for SBIR" and the line "Total Amount Spent on Phase I and Phase II Awards", results from the mechanism by which the SBIR set-aside was assessed. At the beginning of FY 1985, the Department determined the SBIR assessments based on the new budget authority which has been appropriated by Congress. This assessment was based on the amounts for extramural research and development in programs other than the Defense Program which, by law, is exempted from participation in the SBIR program. At the end of the fiscal

VITAL STATISTICS OF THE DOE/SBIR PROGRAM

	FY 1984	FY 1985
Extramural R and D Budget (excluding DOE Defense Programs)	$2,613,300,000	$2,522,700,000
Amount Set-Aside for SBIR	$15,826,000	$25,227,000
Number of R and D Solicitations	1	1
Number of Phase I Proposals	844	861
Number of Phase I Awards	101	110
Amount Spent on Phase I Awards	$4,899,201	$5,416,713
Number of Phase II Proposals	96	91
Number of Phase II Awards	51	46
Amount Spent on Phase II Awards	$11,493,576*	$19,309,063**
Total Amount Spent on Phase I and Phase II Awards	$16,392,777	$24,725,776
Number of Identified Valid Follow-on Phase III Funding Commitments	3	4

* Since Phase II awards are almost always funded in two years, this figure represents about half of the total dollars spent on the 51 Phase II projects initiated in FY 1984.

** This figure consists of about half of the total dollars spent on (1) the 51 projects started in FY 1984 and (2) the 46 projects started in FY 1985.

year, the Department determined the actual extramural funds obligated. The shortage in the original assessment will result in an adjustment to the assessment for the next fiscal year. Accordingly, in order to offset the FY 1985 shortfall, the Department will increase its FY 1986 assessment.

- "Number of Identified Valid Follow-on Phase III Funding Commitments." This number is determined by reviewing follow-on funding commitments only for proposals with lowest fundable merit scores, where the presence of a valid commitment is used as a tie-breaker, as stipulated by Public Law 97-219.

SOME PROBLEMS

We would like to use this opportunity to bring to the Committee's attention two problems. These are:

Eligibility of the Principal Investigator - The SBA Policy Directive stipulates that "the primary employment of the principal investigator must be with the small business firm at the time of award and during the conduct of the proposed effort". It then states that primary employment means that more than one-half of the principal investigator's time is spent in the employ of the small business. Our experience indicates that the term "primary employment" requires further definition to deal, for example, with cases where the principal investigator designated by the small business has other employment, normally considered full-time. We expect to work with the SBA, in consultation with other agencies, to arrive at a language which would minimize confusion in the interpretation of this provision.

Property Acquired Under SBIR Contracts - Public Law 97-219 provides that title to Government-owned property may be transferred to the contractor if such a transfer would be more cost effective than recovery of the property by the agency. Yet, standard Government property regulations do not recognize the unique nature of the SBIR program. Consequently, we are encountering specific instances where the application of Government property regulations is acting as a barrier to further development and eventual commercialization of products and processes resulting from SBIR research. For instance, we might need to remove a vacuum pump from a bench-scale system developed under SBIR, thereby hindering the chances of the contractor attracting non-federal funding to commercialize the system. We therefore suggest that consideration be given to allowing the continued use, for a limited time, of Government-owned property by SBIR participants beyond Phase II in those instances where it can be determined that doing so would foster further development and eventual commercialization of the respective technology.

SBIR PROGRAM EVALUATION

Mindful of the requirement of P.L. 97-219 for the Secretary of Energy to provide to the Comptroller General his judgments as to the effect of the SBIR program on DOE research programs for inclusion in the Comptroller General's report to Congress (due in July of 1987), we are presently undertaking a review of the DOE SBIR program. In doing so, we recognize from experience that typically it takes many years to bring a technical innovation from the stage of exploratory research to commercialization. Thus, a great deal of patience needs to be exercised; while there very well may be some "success stories" shortly following the 2 1/2 years of SBIR funding, the real, significant accomplishments may not materialize until several years later. Accordingly, while the high technical quality of our

SBIR projects gives us every reason to be optimistic about the program's eventual outcome, we must be careful to avoid the temptation either to seek "instant successes" that may be fleeting, or to make rush judgments about the commercialization resulting from SBIR research, where the time to accomplish commercialization clearly has been insufficient.

Mr. Chairman, on this note of caution, we conclude our comments.

UNITED STATES DEPARTMENT OF AGRICULTURE

SCIENCE AND EDUCATION

OFFICE OF GRANTS AND PROGRAM SYSTEMS

COMPETITIVE RESEARCH GRANTS OFFICE

SMALL BUSINESS INNOVATION RESEARCH PROGRAM

REPORT TO

UNITED STATES SENATE

COMMITTEE ON SMALL BUSINESS

MARCH 1986

Our first grants under the Small Business Innovation Research (SBIR) program were made in FY 83. Initial Phase II grants for two years were made in FY 84 and are to be completed in July and August of FY 86. No firms have moved into Phase III as of this time.

There are some Phase II awardees who have been quite successful in their Phase II efforts. Three examples of these are reported below:

(1) Beard Industries, RR 6, Box 19, Highway 28 West, Frankfort, Indiana 46041 (317) 654-8517. Dr. Eugene E. Williams

Engine Driven High Temperature Grain Dryer

This project has produced an interesting spin-off in a new type of grain drying process which does not use expensive hardware. Heat exchangers are placed inside the bulk grain bed for efficient drying. Conventional equipment is used. The process differs from the original proposed concept, but further development of this new concept, using the firm's own funds, is taking place.

(2) Oglevee Associates, Inc., 150 Oglevee Lane, Connellsville, Pennsylvania (412) 628-8360. Robert Oglevee

Model Development for Computerized Plant Environmental Growth Strategies

This grantee has made use of the known factor in the control of the growth of plants that an increase in carbon dioxide concentration will increase photosynthesis and thus the growth of the plants. He has developed a CO_2 sensor which is controlled by a microprocessor and the software to go with it. He maintains a large vegetable and flowering plant greenhouse. CO_2 is produced by burning natural gas, or from a supply of liquid CO_2. He is in the process of further development of computerized control of humidity and light. A 25 percent increase in geranium production has been achieved. His ultimate aim is to model an entire greenhouse operation, including new architectural designs. The CO_2 sensor and microprocessor are now on the market.

(3) Incubator Technologies, Inc., Twitty Park-Research Drive, Route 4, Box 519. Rolla, Missouri 65401 (314) 364-7747. F. Terry Nixon

The "incubator" concept is being pursued by a group in Rolla, Missouri. This firm has provided shared services for other small firms who need not only the physical facilities for management and production, but also business expertise and interaction with related small firms. Access to possible venture capital and state support is provided. The strength of the program lies in the involvement of the community and the University of Missouri at Rolla. Three small high-tech businesses are already successfully occupying the "incubator." The arrangement is not intended to be permanent, so as these firms grow they will move on and other new businesses will be taken in.

* * * * * * * * * * * * * * * *

It is still too early to present an overview of the success of the program. There is an indication that the businesses that are successful with their SBIR grants are those well-run firms that can take full advantage of the funds made available to them, and that may not need additional private funds (Phase III) to produce a saleable product.

TABLE I - USDA/SBIR STATISTICS - FY 84 - FY 85

	FY 84	FY 85
Extramural R&D Budget	$ 280,054,866	315,094,600
Set-aside for Small Business	2,683,292	3,150,946
Number of Solicitations Published	1	1
Number of Proposals, Phase I	328	298
Number of Proposals, Phase II	13	16
Number of Awards, Phase 1	16	23
Number of Awards, Phase II	7	11
Funding Level, Phase I, Total	685,292	1,049,946
Funding Level, Phase I, Avg.	42,831	45,650
Funding Level Phase II, Total	998,000	2,101,000
Funding Level Phase III Avg.	142,571	191,000
TOTAL EXPENDED	1,683,292	3,150,946

UNITED STATES DEPARTMENT OF AGRICULTURE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

ANNUAL REPORT
FISCAL YEAR 1985

October 1985

Prepared by

Science and Education - Office of Grants and Program Systems
Competitive Research Grants Office
Small Business Innovation Research Program
U. S. Department of Agriculture
Washington, D.C. 20251

INTRODUCTION

The following pages include the application statistics and the abstracts of the proposals receiving awards in the Fiscal Year 1985 Small Business Innovation Research (SBIR) Program in the U. S. Department of Agriculture. About forty scientists evaluated the proposals using the criteria published in the 1985 Solicitation. A secondary evaluation was conducted on the highly rated proposals by the panel of topic managers to designate those proposals to receive grants.

The contributions by USDA agencies to the 1985 SBIR program were:

Cooperative State Research Service	$2,775,066
Agricultural Research Service	245,000
Forest Service	79,000
Economic Research Service	16,000
Statistical Reporting Service	5,880
Human Nutrition Information Service	23,000
Agricultural Cooperative Service	7,000
	$3,150,946

SMALL BUSINESS INNOVATION RESEARCH
STATISTICS - FISCAL YEAR 1985

PROGRAM AREA	PROPOSALS RECEIVED	AMOUNT
Animal Production & Protection	61	$ 2,665,302
Air, Water & Soil	34	2,168,332
Plant Production & Production	91	5,091,445
Food Science & Nutrition	38	2,164,062
Rural & Community Development	40	2,072,040
Forest & Related Resources	50	2,787,430
	314	$16,948,831

State	Total No. Submitted Phase I	 Phase II	Amount	*M/D	Women Owned
AL	2		100,000		
AZ	7		360,890	1	4
AR	3		120,264		
CA	48	1	2,497,317	2	4
CO	18	2	1,162,768		2
CT	1		46,720		
DC	2	1	[illegible],142		
FL	15		726,007	2	1
GA	1		50,000		1
HI	4	1	364,690	1	1
ID	5		171,765		
IL	8		381,834	1	
IN	3		96,276	1	
IA	6		286,260	1	1
KS	3		141,264		
KY	1		50,000	1	
LA	4		164,957	1	1
ME	3		112,075		1
MD	12		543,486	2	2
MA	12	1	808,130	1	1
MI	6		278,900	3	2
MN	14	1	805,409	1	1
MS	4	1	199,875	2	
MO	8	1	417,449	2	2
MT	3		121,944		
NE	6	1	445,945		
NV	2		73,000		
NH	1		49,150		
NJ	9	1	606,811		2
NM	2		99,628		
NY	11	2	755,359	1	2
NC	9		438,215	1	1
ND	1		50,000	1	
OH	4		188,654		1
OK	2		94,130		
OR	7		286,825		1
PA	9		398,127	1	2
SD	1		29,049		
TX	9	1	630,803		2
UT	9		409,315	1	
VT	1		30,580		
VA	10	1	613,361		3
WA	16	1	1,001,910	3	2
WV	5		209,907		
WI	7		331,533	1	1
	314	16***	$16,948,831	31*	41**

*M/D - Minority and Disadvantaged

**Some proposals counted twice in these categories, since they were both M/D and Women Owned

***The 16 Phase II proposals are included in the total of 314

Proposal Services Unit
9/25/85

SMALL BUSINESS INNOVATION RESEARCH
ABSTRACTS OF 1985 PHASE II AWARDS

TITLE OF RESEARCH: Reliable Strength Assessment of Wood Composites Utilizing Nondestructive Evaluation Techniques
COMPANY: Engineering Data Management, Inc., Fort Collins, CO 80526
PRINCIPAL INVESTIGATOR: G. Brent Fagan

GRANTED AMOUNT: $195,000/24mos

Phase I - developed methods for reliably assessing the bending strength of wood composite panels will be refined using nondestructive evaluation (NDE) procedures involving spectral analysis of stress-wave parameters. Phase I research has verified the feasibility of this NDE technique. Phase II research will enable detailed refinement of the NDE method ultimately leading to commercial NDE devices for panel products. Currently, no reliable methods exist which can accurately define the strength of individual panels. Phase I research has provided a highly accurate NDE method to predict the strength of individual composite panel sections. Successful refinement of this techniques is anticipated for the Phase II research. Such procedures will improve the efficient utilization of critical wood resources.

TITLE OF RESEARCH: Rapid Detection of Carbamate Pesticides in Food and Environmental Samples
COMPANY: Hawaii Biotechnology Group, Inc., Aiea, HI 96701
PRINCIPAL INVESTIGATOR: Douglas C. Vann

GRANTED AMOUNT: $200,000/24mos

Immunoassays capable of detecting and quantifying carbofuran, aldicarb and carbaryl at sub-picogram levels will be produced. Strategies have been developed for the synthesis of derivatives of each pesticide which can be used as haptens for immunization and solid phase enzyme immunoassays. We proposed to follow a plan wherein easiest synthetic schemes will be attempted first and more difficult procedures will be followed only if necessary. We anticipate producing assays which will specifically detect these carbamates and their oxidation products provided the carbamate moiety remains intact.

TITLE OF RESEARCH: Local Area Leading Indicators
COMPANY: Dual-Comm, Inc., Washington, D.C. 20005
PRINCIPAL INVESTIGATOR: John C. Beresford

GRANTED AMOUNT: $249,000/24mos

The Census Bureau has advanced the release date of county population estimates to within four months of the reference year. This twelve month improvement provides a measure against which to test other indicators of change. The project assembles data to measure fifteen timely county indicators and to analyze the interrelationship of the indicators over time to determine if they predict one another. Eight specific changes will be predicted for 3,137 counties between 1984-1985. If the predictions are successful, then private sector firms will supply resources for Phase II commercial development.

TITLE OF RESEARCH: Laser Diagnostics of Microbial Populations in Food Processing Systems
COMPANY: American Research Corporation, Radford, VA 24143
PRINCIPAL INVESTIGATOR: Russell Joseph Churchill

GRANTED AMOUNT: $249,000/24mos

Many food processing industries require quantification of microorganisms as well as microbial species identification data for quality control, public health and aesthetic purposes. In addition, certain food processing industries would benefit from microbial metabolite identification and concentration data. At present no satisfactory technique has shown consistent results for rapidly quantifying and/or identifying microorganisms in food processing plants. The Phase I program examined the feasibility of utilizing laser induced fluorescence to identify a fluorescent dye with high selectivity among bacteria and the presence of significant differences in fluorescence decay rates of bacteria excited by a pulsed nitrogen laser. Principal findings included a preliminary evaluation of the sensitivity of laser methods to *Escherichia coli* encotoxin and *Salmonella typhimurium*.

The findings of the Phase I project are to be incorporated into a laser diagnostic system having fiber optic sensors for optimizing signal-to-noise ratios in food processing facilities. The research objectives of the Phase II program include evaluation of laser systems for particular food processing applications, selection of demonstrated molecular probes for use with laser diagnostic systems to increase bacteria spectral differences at appropriate wavelengths, design of fiber-optic based laser detection systems for stray light reduction and use in turbid media, determination of signal processing requirements to increase signal-to-noise ratio, development of prototype systems incorporating both continuous wave and pulsed lasers, and demonstration of a portable model measurement system at a food processing plant.

TITLE OF RESEARCH: Enzyme Immunoassay Technology and Fieldable Assay Kits for Plant Pathogens
COMPANY: Bio-Metric Systems, Inc., Eden Prairie, MN 55344
PRINCIPAL INVESTIGATOR: Patrick E. Guire

GRANTED AMOUNT: $249,000/24mos

Plant pathogens are responsible for devastating losses valued at several billion dollars annually to food, fiber, and wood product industries world-wide. An economical and convenient assay kit for the early and sensitive detection and identification of pathogenic viruses, fungi, or bacteria will permit significant reductions in crop losses through prevention and control. This project will utilize current enzyme immunoassay technology and extend its use in a sensitive, rapid, and fieldable means of identifying pathogenic microbes in host plans. A colored spot will be generated on a paper disk upon simple exposure of the assay strip to a sample extract. Initial pathogen targets will be potato viruses S,X,Y, and leafroll.

TITLE OF RESEARCH: Holographic Sunlight Distribution For High Efficiency Greenhouses
COMPANY: Photics, Inc., Westford, MA 01886
PRINCIPAL INVESTIGATOR: Rudolph Bradbury

GRANTED AMOUNT: $230,000/24mos

Greenhouses must meet the conflicting requirements of both admitting substantial amounts of sunlight to the entire growing area and providing very substantial insulation to reduce heat loss in winter and minimize ventilation and cooling costs. Broad bandwidth holograms that are designed to redirect the portions of the solar spectrum required for plant growth can be an ideal solution for admitting and distributing light. This can be accomplished without sacrificing plant production if the remaining area is holographically coated to direct sunlight on to the plants beneath.

The overall Phase II plan is quite straightforward. Two 8 by 12 foot greenhouses will be constructed to serve as a holographic greenhouse and a control. The greenhouses will be set up to monitor radiation levels and spectral distribution and will have suitable control systems to maintain proper temperature and also to monitor supplemental energy use. Holograms will first be made in dichromated gelatin (DCG) on the large four foot substrates. These will be mounted, installed and tested for a growing season and compared with a control. At the same time work will be underway to establish the photopolymer holographic material on a suitable film base. These holograms will then be installed in the test greenhouse for a second growing season. Throughout, testing and evaluation will continue on four foot square of the film based photopolymer and the glass substrate based DCG.

TITLE OF RESEARCH: Systematic Analysis of Central Passage Circular Sawing Process
COMPANY: Efficient Machinery Company, Bellevue, WA 98004
PRINCIPAL INVESTIGATOR: Petter G. Hammerschlag

GRANTED AMOUNT: $250,000/24mos

The central passage circular sawing (CPC) process was deemed to be feasible thus the design and analysis of the system is to be performed. A prototype is to be built using the feed system. The Phase II effort will also empirically determine the capabilities of the CPC concept. Particular attention will be paid to the performance of the drive and guide systems for saw blade and system wear.

TITLE OF RESEARCH: Facilitating the Colonization of Plant Roots by Beneficial Microorganisms
COMPANY: Kamterter, Inc., Lincoln, NE 68503
PRINCIPAL INVESTIGATOR: John A. Eastin

GRANTED AMOUNT: $200,000/24mos

Soil cover & physical characteristics which influence erosion and productivity are markedly influenced by tillage, crop root characteristics and soil microorganisms. Conservation tillage provides cover, desirable physical characteristics and influences microflora makeup. Success in managing the microflora is limited by a lack of technology to allow populations of beneficial microorganisms to survive inoculation and planting. Kamterter Inc. has developed a fluid drilling system which will plant germinated seeds of essentially any size and shape. Phase I work in this project established the technical feasibility of using fluid drilling gels as carriers for beneficial microorganisms.

The proposed Phase II research is aimed at developing basic technique and efficacy information on inoculating and infecting seeds and seedlings with beneficial microorganisms using fluid drilling gel and chemical treatments to facilitate colonization of seeds and crop roots by beneficial microoganisms.

TITLE OF RESEARCH: Development of a Dry Film Assay for The Rapid Detection of Trichinosis in Swine
COMPANY: Innovative Technology, Inc. Hattiesburg, MS 39406
PRINCIPAL INVESTIGATOR: Willard L. Douglas, Jr.

GRANTED AMOUNT: $50,000/12mo

The objective of this project is to develop a simple inexpensive test device which can be used in the field by non-laboratory personnel to screen and detect Trichinella in swine. The test device will be a dry film based on a new and unique immunoassay technique referred to as Immuno-Replacement-Assay. This technique uses low affinity antibodies which have been conjugated to a non-radioisotopic label.

TITLE OF RESEARCH: Development of a High-Tech Incubator Concept for a Rural/University Setting
COMPANY: Incubator Technologies, Inc. Rolla MO 65401
PRINCIPAL INVESTIGATOR: F. Terry Nixon

GRANTED AMOUNT: $100,000/12mo

This Phase concentrates on the identification of the technology niches and of the means that Incubator Technologies,Inc., universities,and regional government agencies could effectively focus their efforts to attract and retain high-tech start-up entrepreneuers.The incubator is to be set up and populated with technical entrepreneuers.

TITLE OF RESEARCH: Management of Field Grafted Grapevines in Cold Climate Vineyards
COMPANY: Hunt Farms Branchport NY 14418
PRINCIPAL INVESTIGATOR: Derek J. Wilber

GRANTED AMOUNT: $129,200/24mo

We propose to learn to balance shoot growth on field grafted vines the year of grafting. We will evaluate the feasibility of whip layering grafted vines so that the graft unions on possibly cold tender trunk portions of the rootstock could be eliminated. We will use grafting techniques developed in Phase I on seedless table grape cultivars. If successfully applied these techniques may reduce the time to renew a vineyard from the present six years to two years.

SMALL BUSINESS INNOVATION RESEARCH
ABSTRACTS OF 1985 PHASE I AWARDS

TITLE OF RESEARCH: A Rapid Method of Quantifying Root Area and Length
COMPANY: Decagon Devices, Inc., Pullman, WA 99163
PRINCIPAL INVESTIGATOR: Grant A. Harris

GRANTED AMOUNT: $33,295/6mo.

The Delta-T area meter accurately measures root lengths and areas. Plant growth modeling efforts are presently discouraged by available tedious and time-consuming procedures for quantifying root growth. The key step needed for automation is separation of live roots from dead roots and other organic debris, in a form that the area meter can recognize. It is the objective of Phase I research suggested in this proposal to determine the feasibility of such automation. A number of fluorochrome dyes are available which cause fluorescence in living plant cells (but not dead) when illuminated by a uv light source. We will investigate adapting the area meter to accurately respond to intensified emissions of such fluorescence. Research will include testing various fluorochromes for usable emissions modifying the area meter with chromatic filters on black and white color TV camera lenses, developing effective uv light sources, and investigating applicability to roots of various plant species.

TITLE OF RESEARCH: An Active Electrochemical Instrument System for Determination of Water Stress
COMPANY: Agricultural Electronics Corporation, Tucson, AZ 85718
PRINCIPAL INVESTIGATOR: William G. Gensler

GRANTED AMOUNT: $49,912/6mo.

An electrochemical instrumentation system will be designed and constructed to determine on command plant water status by means of cyclic voltammetry and/or coulostatics. The approach is based on the change in electrochemical status of the apoplast electrolyte during the normal irrigation cycle. A three window microprobe will be fabricated on a silicon wafer substrate using the planar techniques common to semiconductor electronics. The probe will be placed in the main stem of cotton plants in commercial fields. Solar driven electronics will then apply the in vivo active electroanalytical methods to monitor the change in the electrochemical status of the apoplast electrolyte.

TITLE OF RESEARCH: Integration of Mechanical and Chemical Forest Site Preparation Techniques
COMPANY: Woodland Service, Inc., Moose Lake, MN 557
PRINCIPAL INVESTIGATOR: David L. Eggen

GRANTED AMOUNT: $50,000/6mo.

This project will test the effectiveness of an integrated approach to site preparation for reforestation. The project will involve a machine capable of simultaneously applying chemicals and mechanically preparing a planting spot. This equipment will provide a flexible and systematic tool to increase cost effectiveness of site preparation and reforestation with least biological impact of the site. The equipment will also result in increased efficiency in streamlining now complex and expensive decision making processes and decrease logistical planning problems.

TITLE OF RESEARCH: Natural Ventilation Management of Livestock Buildings using Shape Memory Alloys
COMPANY: Memory Metals, Inc., Stamford, CT 06906
PRINCIPAL INVESTIGATOR: James Stice

GRANTED AMOUNT: $46,720/6mo.

The livestock industry, from an animal production viewpoint, is increasingly using confinement systems to increase producer efficiency. It is very important for these confinement systems to have a good method of controlling the environment surrounding the animal. Present ventilation systems supply ventilation by using electric powered fans and/or doors that are controlled by electric thermostats. The electric systems suffer from high first cost, high maintenance costs, and low reliability. The proposed solution is to design a natural ventilation system that will have a non-electric control device sensitive to temperature. This system would use vents placed within the building skin. A nonelectric control device is possible with the use of shape memory alloys.

TITLE OF RESEARCH: Development of a DNA Probe for the Rapid Detection of *Mycoplasma gallisepticum*
COMPANY: Bionique Laboratories, Inc., Saranac Lake, NY 12983
PRINCIPAL INVESTIGATOR: Steven J. Geary

GRANTED AMOUNT: $49,974/6mo

The objective of this project is to construct a *Mycoplasma gallisepticum* biotinylated DNA probe. Economic losses from *M. gallisepticum* infection are estimated to be $118 million annually in the United States. Minimum efficiency of *M. gallisepticum* disease control requires a rapid and sensitive identification system such as a probe. *Mycoplasma gallisepticum* DNA will be labeled will biotin-11-dUTP in a standard nick-translation reaction. Target DNA hybridized with the biotinylated probe on a nitrocellulose filter will be incubated with streptavidin and polyalkaline phosphastase. Upon addition of an enzyme/substrate complex, the hybridized DNA will appear as a blue spot. Results can be obtained in 24-36 hours, which is considerably faster than routine methods currently in use.

TITLE OF RESEARCH: Lamplight Designed Specifically to Ease USDA Meat-Inspection
COMPANY: Prime-Color, Inc. Wayne NJ 07470
PRINCIPAL INVESTIGATOR: William J. Thornton

AMOUNT GRANTED: $43,167/6mo.

USDA meat-inspectors need to see well. Special lamplight makes easier and more accurate the inspection of poultry and red-meat. The proposal addresses the the feasibility of design of special lamplight for meat-inspection: (1) for many lamp lights, find dependence of its color-temperature, its gamut of coloration, and special indices of coloration of yellowish and reddish samples (meats), on its spectral composition; (2) then do a preliminary actual visual comparison, under various special lamps, of perfect and flawed poultry and red-meat samples.

TITLE OF RESEARCH: Salmonella Measurement With Bioluminescent Immunoassay
COMPANY: Hemogenetics, Inc., San Mateo, CA 94401
PRINCIPAL INVESTIGATOR: Georges P. Der-Balian
GRANTED AMOUNT: $50,000/6mo.

A rapid and very sensitive bioluminescent immunoassay will be used for the detection and measurement of salmonella bacteria in foods. Both polyclonal and monoclonal antibodies to Salmonella will be used. It is hoped to attain detection limits of a few hundred bacteria per ml. in an assay taking only a few hours.

TITLE OF RESEARCH: Palmalloid Microalgae as Soil-Conditioning Agents
COMPANY: R&A Plant/Soil, Inc. Pasco WN 99301
PRINCIPAL INVESTIGATOR: Blaine Metting

GRANTED AMOUNT: $49,596/6mo.

Wind and water erosion of topsoil is a threat to sustained crop productivity in the United States. Laboratory and field experiments will be integrated in a feasibility assessment of reducing erosion of sandy, center-irrigated soils by means of mass cultured palmelloid microalgae in the genus*Chlamydomonas*. Studies are designed to quantify *in situ* productivity, extracellular polysaccharide production and degradation potential. Productivity will be estimated by filter fluorometry: degradation by radiorespirometry. Wind and water erosion potential will be estimated by wet and dry stability of aggregates.

TITLE OF RESEARCH: The Use of X Rays to Disinfest Grapefruit of Carib Fly Within The Packinghouse
COMPANY: Citrex Technologies, Inc., Gainesville, FL 32602
PRINCIPAL INVESTIGATOR: Mary Ann H. Ogden

GRANTED AMOUNT: $49,815/6mo.

The use of X rays to Disinfest citrus of carib fly *Anastrapha suspensa* (Lowe) in shipments to Japan will provide an attractive alternative to chemical fumigation and gamma-ray irradiation when used in conjunction with normal processing procedures within packinghouses. It will save on shipping and labor costs and eliminate fruit damage from excessive handling. It will also eliminate problems encountered from the environmentally unsound practice of chemical fumigation.

TITLE OF RESEARCH: Rapid, Novel Methods for Sensing Protein and Protein Quality
COMPANY: Universal Sensors, New Orleans, LA 70148
PRINCIPAL INVESTIGATOR: Glenn Lubrano

GRANTED AMOUNT: $40,625/6mo.

Novel and rapid assay procedures will be developed for the determination of total protein quality of foods. For total protein, a specific electrode will be developed that will effect a fast (<5min.) hydrolysis of protein to L-tyrosine, followed by a specific L-tyrosine assay. For protein quality, specific L-lysine and L-methionine electrodes will be used to develop a rapid CPER assay. A specific electrode for sucrose will be developed, which is capable of direct on-situ analysis.

TITLE OF RESEARCH: Lumber Yield Optimization Through Market-Responsive Log Yard Management
COMPANY: Mater Engineering, Ltd., Corvallis, OR 97339
PRINCIPAL INVESTIGATOR: M. Scott Mater

GRANTED AMOUNT: $47,520

This research will evaluate the feasibility of a new market-responsive sawmill log yard inventory management system (LIMS). Sawmills use sawing systems to optimize the value and yield of lumber from individual log delivered randomly to the log deck. Currently no existing systems select those logs from inventory which will best yield the lumber product mix required by the order file. LIMS would select optimal logs for the log deck, directly tying the lumber products to the log resource. Random feeding of logs to the mill underutilizes the log inventory, decreasing the values and yields of lumber products from the Nation's forest. This research will test the technical and economic feasibility of networking log yard inventory into a coordinated millwide market-responsive system.

TITLE OF RESEARCH: A New Method for Efficient Mapping of Human Geographical Boundaries in Rural Areas
COMPANY: SRM Corporation, Denver, CO 80211
PRINCIPAL INVESTIGATOR: James A. Kent

GRANTED AMOUNT: $49,500

The location of Human Geographical Boundaries currently provides one of the bases in several U.S. Forest Service Regions, for instance, for resolving social/cultural issues and problems related to the development of rural areas. This project will attempt to determine a more efficient yet reliable method for describing Human Geographical Boundaries using quantitative methods. Human Geographical Boundaries have been shown to be an effective planning tool, particularly in regard to rural areas, because they assist in more sensitive project siting, reveal important differences in cultural values and lifestyles and indicate boundaries of project impacts. The present system for describing human social values is qualitative in nature, expensive and time-consuming. The new method to accomplish the same purpose will be cheaper and quicker

TITLE OF RESEARCH: Containerized Bulk Export Shipment of Wheat Flour and Other Powder and Granular Food Products
COMPANY: Lembeck Associates, Inc., Overland Park, KS 66210

GRANTED AMOUNT: $48,709

Recognizing serious constraints associated with present methods of export movement of food staples such as wheat flour to developing countries, the researcher proposes a containerized system. The concept eliminates the use of bags and substitutes self discharging sealed containers with specialized vessels. The proposed system would permit movement of products from the U.S. producing point to foreign consumption points in manageable bulk quantities protected from loss and damage. The research is directed towards analysis of the overall economic and financial feasibility of the proposed system, as well as its impact on specific segments of industry and governments. In addition, the research will address technical problems associated with the proposed system.

TITLE OF RESEARCH: A Realistic Approach to Reduce Cost and Improve Effectiveness of Gypsy Moth Parasites in IPM
COMPANY: National Gypsy Moth Management Group, Inc., Landisburg, PA 34776
PRINCIPAL INVESTIGATOR: Mark Ticehurst

GRANTED AMOUNT: $34,776

Losses resulting from gypsy moth in the northeast in 1981 alone were $764,000,000. This pest is dispersing to 500,000 acres per year into areas of its perferred food, the mid-Atlantic states. More than ten isolated infestations have been discovered throughout the United States, including California, Oregon, and Washington.

Preliminary experiments in 1984 with a newly imported parasite, Cotesia melanoscela, Korean strain (Hyimenoptera: Braconidae), demonstrated extremely high rates of parasitism of gypsy moth larvae. This parasite is ideally suited for IPM programs because of its host specificity, synergistic response with bacillus thuringiensis, overwintering potential, and its protective silken 'halo' surrounding the overwintering cocoon. The limiting factors for the use of C. melanoscela are high production costs and lack of release rate prescriptions.

The objectives of this proposal are to reduce production costs by testing and selecting superior combinations of the following: parasite-host density, host and parasite age, and environmental conditions. Prescriptions for parasite release rates are developed from variable parasite: host density experiments conducted in outdoor insectaries and forested woodlots.

TITLE OF RESEARCH: Artificial Seeds:Encapsulation of Plant Somatic Embryos
COMPANY: Plant Genetics, Inc., Davis, CA 95616
PRINCIPAL INVESTIGATOR: M. Keith Redenbaugh

GRANTED AMOUNT: $47,880

Artificial seeds provide a clonal system to propagate elite and improved germplasm of seed crops such as alfalfa, without the prerequisite of meiotic recombination. Although clonal propagation has been used for vegetatively-propagated crops for millennia, such propagation has not been available for seed crops prior to the discovery of plant tissue culture techniques. The first steps for creating artificial seeds (i.e., somatic embryogenesis and embryo encapsulation) have been accomplished at PLANT GENETICS, INC. The Phase I objectives of this proposal are to resolve three research questions using the advanced alfalfa somatic embryogenesis system.

1. Can the germination frequency of somatic embryos be increased to approach that of true seeds?

2. Can the capsule matrix be modified to serve as an artificial endosperm?

3. Can encapsulated somatic embryos be germinated under greenhouses conditions?

To accomplish these objectives, somatic embryos produced under various conditions will be analyzed for seed-specific storage proteins to assess embryo quality. Secondly, various carbohydrates and nutrients will be incorporated into the capsule matrix, either uniformly mixed in the matrix or in an immobilized state. Thirdly, success in the first two objectives should then enable the improved somatic embryo, encapsulated in a rich artificial endosperm, to germinate and develop under greenhouse conditions.

TITLE OF RESEARCH: Stress Wave Analysis of Wood Piles Related to Ultimate Compressive Strength
COMPANY: Aminex Company, Federal Way, WA 98063-4174
PRINCIPAL INVESTIGATOR: Robert D. Arsenault

GRANTED AMOUNT: $45,970

Wood foundation piling could be utilized for capacities of 2 to 3 current design loads if the high strength piles could be readily identified by a non-destructive test method. Wood piles would be appreciated by geo-technical and structural engineers as an economical and reliable deep foundation capable of higher design stresses if the low-strength piles were rejected. A feasibility study will determine the degree of correlation between the longitudinal stress wave propagation along the length of the untreated piles and the failure stress in compression parallel to grain of the treated wood pile tips. The non-destructive testing technique will be developed, including testing devices.

TITLE OF RESEARCH: Inoculation Techniques for Forest Mushrooms (L. edodes) Production
COMPANY: American Forest Mushroom Association, Inc., Asheville, NC 28802
PRINCIPAL INVESTIGATOR: Toby J. Farris

GRANTED AMOUNT: $49,860

The forest mushroom (shiitake) is the only gourmet class of mushroom that can be commercially cultivated. It is primarily grown in Japan, principally by over 170,000 small lot growers. The current annual world and U.S. markets exceed $1.58 billion and $10 million respectively. In rural southeast United States over 2 million private non-industrial forest land owners own over 70% of the commercial forest land, much of it undermanaged and not commercially valuable. By introducing and demonstrating the feasibility of using the shrub hardwoods resulting from timber stand improvement for cultivation of an alternative crop-forest mushrooms, small woodlot owners will benefit from a secondary income, and be motivated to improve the future commercial value of their timber.

New horticultural standards and technology must be developed since current commercial techniques and supplies for inoculating of host logs with Lentinus edodes mycelium remain crude, resulting in limited crop production and inefficient labor. The standard spawn dowel causes fractures an the bark and sealing parafin wax dries out and chips off, allowing excessive weed fungi infestation and moisture loss. Research will complete development and testing of an innovative spawn dowel design, sealing wax formula and drill bit design that will increase crop yield and reduce labor costs

TITLE OF RESEARCH: Aiding Rural Governments and Institutions Through Voice Messaging
COMPANY: Associated Enterprise Development, Inc., Annapolis, MD 21401
PRINCIPAL INVESTIGATOR: Leonard A. Blackshear

GRANTED AMOUNT: $44,895

Local government and public institutions in rural areas are faced with communication gaps in the gathering, sharing, and dissemination of information due to changes in the complexion and needs of their constituency, new legislation, technological advancements, social changes turnovers in leadership, and changes in the economy. Under Phase I, we propose to establish the technical merit and feasibility of using voice messaging technology as an information exchange vehicle. The hypothesis is: using voice messaging technology, it is possible to develop an effective business and community development information and assistance exchange network linking local government and public institutions in rural areas with: (1) their own constituents, (2) State, regional and national authorities, (3) other local governments and public institutions, and (4) a prerecorded supplemental library of useful information. AEDI's work plan will include: (1) the private sector rural business and community development authorities: (2) the implementation of a trial information exchange system; (3) the evaluation of the technical merit and feasibility of integrating voice messaging technology identification of prospective capital commitments for commercial applications.

TITLE OF RESEARCH: Unique Measurement of Nutrients Fluxes Using Fiber Optics
COMPANY: ST&E Technical Services, Inc., San Ramon, CA 94583
PRINCIPAL INVESTIGATOR: Stanley M. Klainer

GRANTED AMOUNT: $40,000

Ultra-small, non-destructive fiber optic chemical probes (optrodes) will be developed for nutrient flux studies. These probes will be used for the *in situ* measurement of the primary plant nutrients in soils, synthetic rooting media and in-plant vascular systems to study the flux dynamics. The optrodes are fluorescent chemical sensors capable of giving both spatial and temporal information about the chemical species present. The optrodes are used in conjunction with a special laser fluorimeter. The Phase I effort focuses on the development of a 100 pm o.d. potassium probe to be used for proof of principal. Preliminary 3-dimensional measurements of potassium behavior in soils and synthetic media will be made.

TITLE OF RESEARCH: Supercritical Fluid Extraction and Analysis of Residues in Meats
COMPANY: Lee Scientific, Inc. Provo, UT 84601
PRINCIPAL INVESTIGATOR: Douglas W. Later

GRANTED AMOUNT: $49,996

Analytical methods for detecting pesticides, antibiotics, and metabolic products in meat products are tedious and time-consuming. This study will evaluate supercritical fluid extraction and chromatographic techniques for analysis of these compounds which may be polar, thermally unstable, or otherwise intractable to other methods. In Phase I, we will demonstrate analysis of residues by SFC; demonstrate supercritical fluid solubility effects, and evaluate SFC detectors. Subsequent phases will develop improved detection and pumping systems and new capillary column coatings optimized for specific assays of interest to the USDA.

TITLE OF RESEARCH: Fiber Optic Chemical Sensors for *in situ* O2, CO2, and H2O Measurements During Photosythesis
COMPANY: ST&E Technical Services, Inc., San Ramon, CA 94583
PRINCIPAL INVESTIGATOR: Stanley M. Klainer

GRANTED AMOUNT: $40,000/6mos

The investigation of photosynthetic processes is limited by chemical analysis technology. No satisfactory method exists for either making invasive measurements within, or in the microenvironment around, living plants. The objective of this research is to develop a suite of highly miniaturized fiber optic probes (optrodes) for the *in situ* determination of the photosynthetically exchange gases: CO2, O2, and H2O. The optrode will provide needed verification of assumptions regarding the composition of the internal and external atmosphere of plant leaves, and of the soil atmosphere and respiration by below-ground plant structures.

TITLE OF RESEARCH: The Feasibility of a Manual for Rural Economic Developers
COMPANY: E P Systems, Inc. State College, PA 16801
PRINCIPAL INVESTIGATOR: Eugene J. Bazan

GRANTED AMOUNT: $42,736/6mos

Rural areas have numerous investment opportunities which are overlooked. The absence of adequate data on the local economy makes publicizing such opportunities difficult and impedes rural development. Rural counties have neither the expertise nor the funds to readily correct this problem. This project assesses the feasibillity of a self-help *Manual for Rural Economic Developers* to provide needed data on local economic structure. Field tests in six rural Pennsylvania counties are used to determine (a) the ability of rural development groups to collect data on local instruments; and (b) the ability and willingness of bisiness people to provide specific linkage data on their activities.

AVAILABLE

TITLE OF RESEARCH: A Non-Instrumented Immunoassay for Aflatoxin B1
COMPANY: Idetek, Inc. San Bruno, CA 94066
PRINCIPAL INVESTIGATOR: Printhipal Singh

GRANTED AMOUNT: $45,000/6mo.

The objective of this project is to develop a simplified, non-instrumented immunoassay system for the detection of Aflatoxin B1 in agricultural commodities. This system will be suitable for field monitoring and, where appropriate, blending of product. Visually readable standards will be developed at 20, 100 and 200 ppb. The system will be evaluated against standard ELISA and HPLC methodologies.

DEPARTMENT OF HEALTH & HUMAN SERVICES

FOR RELEASE ONLY UPON DELIVERY

STATEMENT OF
DR. WILLIAM F. RAUB
DIRECTOR, OFFICE OF EXTRAMURAL RESEARCH
AND TRAINING
NATIONAL INSTITUTES OF HEALTH

PUBLIC HEALTH SERVICE
DEPARTMENT OF HEALTH AND HUMAN SERVICES

FOR THE RECORD OF
SUBCOMMITTEE ON INNOVATION AND TECHNOLOGY
COMMITTEE ON SMALL BUSINESS
UNITED STATES SENATE

MARCH 25, 1986

Mr. Chairman and Members of the Subcommittee:

The Department of Health and Human Services (DHHS) appreciates this opportunity to apprise the Committee of the implementation of our Small Business Innovation Research (SBIR) Program and to share with you some observations derived from our experience over the last three years.

The principal operating components that participate in our SBIR Program are the Public Health Service (PHS), the Health Care Financing Administration (HCFA) and the Office of Human Development Services (OHDS): of these, the PHS accounts for over 97% of the activity.

Within the PHS, the NIH was designated the lead agency, primarily because of its long-standing experience in supporting research and the amount of its extramural research and development budget that would be set aside for SBIR awards. The NIH SBIR set-aside alone constitutes 92% of the Department's set-aside. The other participating components of the PHS are the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA), the Health Resources and Services Administration (HRSA), the Food and Drug Administration (FDA), the Centers for Disease Control (CDC), the National Center for Health Services Research and Health Care Technology Assessment (NCHSR/HCTA), and the Office of Adolescent Pregnancy Programs (OAPP). As lead agency for the PHS, the NIH works to ensure that SBIR policies and procedures are implemented in a manner that is consistent with both the enabling legislation and pre-existing agency mission requirements.

Since the inception of the SBIR Program, the PHS (particularly NIH) has arranged for its

SBIR coordinators to participate in regional and statewide conferences and workshops throughout the year to inform groups and individuals about the SBIR Program. In addition, the NIH, on its own initiative, has carried out a variety of activities to inform the small business research community about SBIR funding opportunities.

- In February 1983 the PHS sponsored a two-day SBIR conference at NIH which attracted approximately 450 persons representing over 300 small businesses. At that conference small business participants were given the opportunity to attend twenty separate technical presentations and to meet with agency staff for individual discussions.

- In October 1984 NIH conducted two regional workshops to provide opportunities for health research oriented small businesses to learn about the PHS SBIR Program in more detail. Topics that were addressed in these workshops included the preparation of grant applications, the NIH process of reviewing applications for scientific/technical merit and various financial aspects of SBIR proposals/awards.

- Last year NIH sponsored and organized a PHS-wide SBIR conference in Washington, D.C., in which all the PHS agencies and NIH awarding components participated. Program staff of every agency and component were present to meet with small business representatives on a one-on-one basis to provide technical assistance as well as to answer questions.

As a result of these efforts by NIH to publicize the SBIR Program and to stimulate increased interest by small businesses, one of the concerns that we had previously - that of an inadequate pool of potential applicants - is no longer a problem. For the record, to date approximately 2,180 organizations have submitted SBIR proposals and a total of 570 have been awarded SBIR grants and/or contracts. In FY 1985 approximately two-thirds of those companies receiving SBIR awards from the PHS were organizations that were new to our SBIR Program.

In implementing the SBIR Program within the PHS, we selected the grant instrument as the primary mechanism of support. The PHS made its choice for two reasons--one philosophical and one practical. First, we wanted an approach that would attract a wide range of research ideas from the small business community as well as from agency staff; and we are mindful of the PHS experience over the past four decades showing clearly that the grant is unrivaled as a means of fostering the initiative of individual biomedical and behavioral scientists. Second, as a practical matter we had to implement the SBIR Program within our traditional budget framework; and it has consistently been the intent of both Appropriations Committees as well as the Executive Branch that NIH use grants to fund the vast majority of research projects, especially those that are initiated and directed by awardee scientists themselves.

The other components of the HHS share this philosophy. However, due to a provision in their legislative authorities that prohibits awarding of grants to for-profit organizations, HCFA and OHDS selected the cooperative agreement as their mechanism of support for SBIR awards. As defined under P.L. 95-224, the cooperative agreement is an assistance mechanism similar to the grant but which allows for substantial involvement by the awarding agency's staff during the conduct of the research.

In FY 1985 the PHS SBIR Program introduced the use of contracts as an additional funding instrument. Our reason for doing so was based on the recognition that, in addition to investigator-initiated research, there are specific technical requirements identified by agency staff that can and should, in accordance with P.L. 95-224, be met through use of the contract instrument. Thus the PHS solicited contract proposals in a number of areas which represented specific research needs of our scientific programs. The two contract solicitations that were issued in FY 1985 drew a response of 379 proposals, 156 of which were funded as Phase I projects. While grants will remain the primary funding instrument for SBIR awards made by the PHS, contracts play an important role in that they make possible the conduct of research which is primarily for the direct benefit or use of the Government.

Now that we have completed the first three years, we are pleased to report that the Departmental SBIR Program has been quite successful. In its first year, FY 1983, DHHS reviewed 779 applications and awarded 139, amounting to $7.3 million, exceeding our set-aside requirement by $664,000. Of the total amount, 90% or $6.55 million was accounted for by the grants awarded by NIH.

In FY 1984, 921 applications were reviewed of which 226 were selected for Phase I funding and 56 for Phase II awards. These grants totalled $23,320,232, with the lion's share ($20,970,000) of the funds being awarded by NIH. Once again, we awarded more SBIR funds than was mandated by P.L. 97-219 - this time in the amount of almost $760,000. Last year (FY 1985) the Department reviewed 1,342 SBIR proposals and made 439 Phase I and 109 Phase II awards, exceeding our set-aside requirement of $43,335,492 by almost $400,000.

At the SBIR oversight hearings held by this Subcommittee on March 1, 1984, we had previewed some of the plans that were underway to improve the implementation of our SBIR Program. We are pleased to report that in FY 1985 NIH did establish a cadre of health scientist administrators who specialize in managing the SBIR review process. This cadre is fully conversant with the objectives, policies, and requirements of the SBIR Program. Its staff members are not only knowledgeable about the array of technical capabilities represented by small R&D firms but also familiar with the types of small business organizations that submit SBIR grant applications.

We have also instituted three application receipt dates annually rather than limit the small business community to a single opportunity each year. This approach has been very well received by the small business community. This means that, if a company misses one deadline, it need wait only four months, not a year, for the next submission date. There are operational advantages as well. The establishment of three cycles per year spreads the review workload over the full year and, by operating in synchrony with our regular processes, achieves important economies of scale. One of the features that is part of this three-cycle-per-year approach is that both Phase I and Phase II applications are accepted on each receipt date.

Having described our first three years' experience with the SBIR Program, we would like to bring the Subcommittee up to date on an issue that has been the subject of some interest and speculation: the quality of the research funded by the DHHS and particularly the NIH SBIR Program. In FY 1984, the second year of the Program, the NIH SBIR set-aside funds more than tripled from the previous year, going from $6.07 million to $20.7 million. That year the number of grant applications submitted to NIH did not triple. Consequently, in a few Institutes at NIH, specifically the National Cancer Institute (NCI), all approved grant applications, regardless of score, were funded. This led to the well publicized case of a grant application with a score of 499 that was funded by NCI. (Priority scores range from 100 to 500. One hundred denotes the highest and 500 the lowest scientific merit of an application recommended for approval.)

Since then the quality of SBIR applications has improved significantly as the numbers have continued to grow. The SBIR mean score of 250 compares favorably with the mean score of 227 for NIH regular research grant applications. While the average quality of SBIR grant awards, as reflected strictly by scores, appears to be slightly lower than that of our regular grants, last year some Institutes, e.g., the National Eye Institute, the National Institute of Child Health and Human Development and even the National Cancer Institute, funded SBIR applications with scores essentially equivalent to those funded in their regular research grants program. Thus we are confident that the quality gap between NIH SBIR awards and traditional project grants is proving to be evanescent.

Another matter that we would like to bring to the Subcommittee's attention is the question of the eligibility of organizations and individuals seeking SBIR funding. While the SBIR Policy Directive issued by the Small Business Administration does define, in general terms, the eligibility requirements of the SBIR Program, the PHS has found that, in several instances, organizations and/or principal investigators that did not and could not meet such requirements were nonetheless submitting SBIR proposals. In most of these cases, it was the principal investigator who did not appear to meet eligibility requirements because his/her primary employment relationship was with an institution of higher education. In discussions with other federal agencies, we have determined that this problem is not unique to the PHS although, given the areas of research that are traditionally funded by NIH and the historically strong involvement of universities in biomedical research, this problem may occur with more frequency within our agency than in others.

In order to minimize, if not eliminate, this problem and to help ensure that the PHS SBIR Program operates in accordance with both Congressional and Executive Branch expectations, the PHS SBIR Solicitations have been revised to state very explicitly our policy with respect to enforcement of the SBIR eligibility requirements. This policy calls for all proposals to be checked for eligibility prior to subjecting them to scientific and technical merit review. Organizations submitting proposals indicating questionable eligibility will be given an opportunity to submit information to verify or substantiate the eligibility of the organization or principal investigator, whichever is in question. If the principal investigator's eligibility has not been established by a given date, the proposal will be returned without further review. If the organization's eligibility is not verified by the specified deadline, the proposal will be referred to the appropriate SBA regional office, in accordance with Federal Acquisition Regulations, Subpart 19.3, for determination of eligibility. We also are double checking awards made prior to the introduction of this stringent screening process. We believe that these steps will go a long way toward minimizing this problem.

Parallel with our internal efforts to address the issue of eligibility, we are also working closely with other federal agencies to develop more specific language that could be recommended to the SBA for inclusion in its Policy Directive. It is our common belief that more explicit guidelines consistently applied across all participating agencies will be very helpful. First, they would make clear the eligibility rules so that interested organizations and principal investigators would have no doubt regarding their own eligibility to participate in the SBIR Program. Second, more specific uniform guidelines would greatly reduce the number of cases in which one agency makes an SBIR award to an organization that has been or will be denied such an award by another agency on the grounds of ineligibility. Third, clearer language on eligibility requirements should deter ineligible organizations and principal investigators from submitting proposals.

In response to the Subcommittee's request for suggestions that might improve the efficiency of the SBIR Program, we wish to reiterate our previously stated concern about the current process in which applicants must receive a Phase I award before being eligible for Phase II. While we appreciate the intent of this structured process, we believe that the interests of both the small business community and the Federal agencies would be served by allowing occasional exceptions. There are instances where small businesses have completed their feasibility studies without SBIR funds and are ready to apply directly for Phase II support. In the area of commercialization, where the lag time between product development and marketing is already unacceptably long to many, any strategy that will shorten the timeframe merits consideration. We understand the concern that such an approach would invite potential applicants to apply for the larger awards in Phase II without carrying out the Phase I effort, but we are confident that this potential problem can be avoided by establishing strict requirements for documentation of the Phase I effort and its results and by ensuring that our reviewers give this documentation close scrutiny.

In conclusion, the Department of Health and Human Services is pleased with the implementation and progress of its SBIR Program and is committed to its continuing success. We hope our comments are helpful to the Committee in its oversight of this important initiative.

National Aeronautics and Space Administration

Small Business Innovation Research (SBIR) Program

Statement for the Record

NASA'S SBIR Program has begun its fourth annual cycle. A cycle begins with an annual solicitation, published each spring, inviting Phase I proposals in topics and subtopics of interest to NASA. A total of 379 Phase I proposals were selected for award in the 1983, 1984, and 1985 programs, and a total of 129 Phase II award selections were made as follow-on to the 1983 and 1984 Phase I contracts, a number of which are still in contract negotiation. We anticipate that at least 60 Phase II award selections will be made in October 1986 as follow-on to 1985 Phase I contracts.

The 1986 Program Solicitation will be issued during April 1986, and the solicitation will close in late June 1986. It will include 15 technical topics subdivided into 180 subtopic areas in every area of aeronautics, space technology, and operations in which NASA is involved. We anticipate selecting, by early October 1986, approximately 110 proposals for Phase I awards from the 1986 solicitation.

PROGRAM STATISTICS

NASA's SBIR program statistics for the first 3 years are listed in Tables I and II. Table I lists the numbers of Phase I and Phase II proposals received, awards made or currently being negotiated, funds applied to each year's Phase I and Phase II programs, and the average award values. Table II lists NASA's annual research and development (R&D) budgets and the portions allocated each fiscal year to the SBIR program. The funds actually expended (obligated) in fiscal years 1984 and 1985 were $4.980M and $29.403M, respectively. Differences between those numbers and the SBIR budget allocations for fiscal years 1984 and 1985 shown in Table II result from the inherent phasing requirements of the program. Funds set aside for SBIR in any fiscal year may support portions of three annual programs.

Table I also shows the numbers of Phase II proposals and awards for which Phase III follow-on funding commitments were identified. Approximately 57 percent of all 1983 Phase II proposals and 59 percent of all 1984 Phase II awards indicated such commitments.

PROGRAM ASSESSMENT

Although we are entering the fourth program year, it must be noted that Phase II contracts, which represent the principal R&D activities, are only now getting well underway. The first group of Phase II contracts (1983 Program Year) was placed within the last 15 months, while many of the 1984 Program Year Phase II contracts are still being negotiated. Phase II contracts are typically of 2 years' duration and, at this time, no Phase II contract has been completed. Therefore, it is too early to evaluate the technical program comprehensively or to predict the ultimate value of the R&D either to NASA or the small business firms involved in the program, or to assess the program's impact on the national economy. Nevertheless, some preliminary findings and views are available, and these are quite positive.

Since the enactment of the SBIR statute, NASA management and researchers have developed a strong support of and enthusiasm for the program. NASA has found that a great number of new and attractive approaches to problems and opportunities identified in the program solicitation have been offered by a large number of innovative small firms. Most of these ideas had not previously been volunteered to NASA by those firms, and possibly would never have been in the normal course of events. The SBIR opportunity and stimulus made it possible for many of these ideas to reach NASA's attention and to be funded. Of course, a number of the proposals received the first year and in subsequent years were judged not to have great merit; nevertheless, we were greatly pleased with the high incidence of high-quality, thoughtfully-developed R&D proposals.

One conclusion, based on 3 years of experience in the program, is that the SBIR Phase I - Phase II approach and program management philosophy have provided a very cost-effective means for exploring new ideas rather quickly. The rapid response capability of our SBIR firms and their generally high motivation and skill levels have proved to be genuine assets in our overall program. SBIR contract efforts are now viewed as integral and important elements of the overall NASA R&D program, albeit comprising a relatively small total increment. Among the SBIR projects are the development of new analytical methods, designs, software, and hardware for direct use by NASA in our total R&D and operational program activities.

ACHIEVEMENT OF SBIR OBJECTIVES

It is somewhat premature to assess how well objectives stated in the statute are being achieved in the NASA program. As the program proceeds, we will evaluate this topic but, at this moment, we can merely report indications. As noted previously, it seems clear that SBIR has been successful in the objective of drawing many small businesses into the NASA program. There is also evidence that the SBIR objective of fostering commercialization of innovations already appears to be successful in a number of instances. Several of the firms in the program have indicated that they have acquired viable commercial capabilities and financial backing as a direct result of R&D they have pursued in our (and other agencies') SBIR programs.

Finally, there is also evidence that the objective of encouraging greater participation of minority and disadvantaged persons in NASA's program is being achieved. During FY 1985, 11.6 percent of the SBIR funding obligations went to minority and disadvantaged small businesses.

IMPLEMENTATION PROBLEMS

While we have developed the SBIR management philosophy and procedures through an iterative process, we have experienced no unique problems in implementing the program. We are pleased with the smoothness of the program's conduct so far, and with its incorporation at our Field Centers as a desirable part of their programs.

SUGGESTIONS TO INCREASE PRODUCTIVITY

At this juncture, NASA has no specific recommendations on how to improve the program except, perhaps, in the area of procurement. Public Law 97-219 directs that ways be found to minimize the "regulatory burden associated with participation in the SBIR program for the small business concern" in pursuing its program. Our perception is that many small businesses, unaccustomed to Government procurement requirements, find these requirements excessively burdensome, yet we are not at liberty to relieve most requirements or to reduce much of the burden. We believe that this area of concern deserves greater study.

TABLE I

NASA SBIR PROGRAM STATISTICS FOR FIRST THREE PROGRAM YEARS

PROGRAM SOLICITATION YEAR	PHASE I				PHASE II						TOTAL PROGRAM FUNDING $M
									PHASE III FUNDING COMMITMENTS		
	PRO-POSALS	AWARDS	TOTAL FUNDING $M	AVERAGE FUNDING $K	PRO-POSALS	AWARDS	TOTAL FUNDING $M	AVERAGE FUNDING $K	TOTAL	AWARDS	
1983	977	102	4.93	48.3	92	57(1)	23.27	408	54	37	28.20
1984	919	127	6.23	49.1	113	71	32.91(2)	463(2)	62	38	39.14(2)
1985	1164	150	7.43	49.5	NA	NA	32.0(3)	NA	NA	NA	39.43(3)
TOTALS TO DATE	3060	379	18.59	49.1	205	128	88.18	439	116	75	106.77

NOTES: (1) ONE 1983 PROGRAM YEAR PHASE II CONTRACT STILL IN NEGOTIATION NOT INCLUDED IN THIS LIST.

(2) 1984 PROGRAM YEAR PHASE II AND TOTAL FUNDING ARE ESTIMATES PENDING COMPLETION OF PHASE II CONTRACT NEGOTIATIONS.

(3) 1985 PROGRAM YEAR PHASE II AWARDS WILL NOT BE MADE BEFORE LATE 1986. PHASE II AND TOTAL FUNDING ARE ESTIMATES.

TABLE II

NASA SBIR FISCAL YEAR FUNDING

	FISCAL YEAR 1983	FISCAL YEAR 1984	FISCAL YEAR 1985	FISCAL YEAR 1986
NASA R&D BUDGET $M	2473	2205	2425	2609
% R&D BUDGET FOR SBIR	0.2	0.6	1.0	1.25
NASA SBIR BUDGET $M	4.94	13.23	24.25	32.61

1986 MAR 12 PM 1:28

NPI

417 Wakara Way
Salt Lake City, Utah 84108
(801) 582 0144
TELEX 820832NPISLC

March 10, 1986

Senator Warren Rudman
Senate Small Business Committee
United States Senate
428A Russell Senate Office Building
Washington, D.C. 20510

Dear Senator Rudman:

Mr. Waddell of your staff recently asked if NPI might be able to appear before your hearings for the reauthorization of the Small Business Innovation Research Program. Since we were unable to make the hearing schedule, we wished to express our strong interest in the SBIR programs and their continuation.

NPI has received SBIR award from the National Science Foundation, the Department of Energy, the Department of Agriculture and the Deparment of Defense. We were awarded several of the NSF awards prior to the national SBIR program was enacted. I thought you and other members of the Senate Small Business Committee might like to know of our experience on two of these projects.

NPI received two Phase I and subsequent Phase II SBIR awards from the National Science Foundation. These programs were designed to conduct research on mycorrhizal soil fungi and the mapping of plant genes using recombinant DNA technology. In each instance, NPI would not have had the resources to pursue these research topics without NSF assistance. Upon completion of the Phase II research, NPI received several million dollars of venture capital financing to pursue the Phase III developmental activities. In each case, the ventue capitalists indicated their support had been based, in part, by the early National Science Foundation support.

The company now offers products from these two research programs to various agricultural markets. Our Nutri-link mycorrhizal fungi are beneficial soil microorganisms which help growers significantly reduce their need for chemical phosphate fertilizers and other nutrients. In the second case, NPI is now the first company in the world to have developed a molecular genetic linkage map for both corn and tomato which has identified the location of important genes at the DNA level. This genetic information will allow the development of superior hybrids which could not be created by conventional plant breeding techniques alone. The enclosed material illustrate NPI's Nutri-link soil inoculant and gene mapping technology.

March 10, 1986
Senator Rudman
Page Two

The potential of biotechnology has been discussed in many forums including the Congress' own Office of Technology Assessment. This new technology will only provide its multiple benefits through products successfully utilized by various consumers. The NSF awards allowed the company to pursue this frontier biological research which would not have been otherwise possible. We believe the SBIR programs is particularly valuable to small high technology companies that wish to pursue exciting research areas which would not be open to them through traditional govermental research programs.

NPI strongly supports the re-inactment of the SBIR legislation and hope these comments have been useful.

Sincerely yours,

Wm Hugh Bollinger

W.H. Bollinger, Ph.D.
Vice President

WHB:ed

Enclosures

Environmental Protection Polymers, Inc.
13414 Prairie Avenue • Hawthorne, CA 90250 • (213) 970-9100

March 7, 1986

Ms. Ann Kaplin
c/o Senator Warren Rudman
U.S. Senate
Washington, DC 20510

Dear Ms. Kaplin:

It is our pleasure to provide your office with the enclosed pictorial presentation of the first commercial size waste module by our technology. The module was fabricated by our company employing the apparatus constructed under sponsorship of SBIR/DOE. It was displayed on March 4, 1986 at the Waste Management '86 Conference in Tucson at one of the booths allocated to authors of papers along with a pictorial presentation, 150 copies of our paper to be published in the conference proceedings, and laboratory size samples of many other waste types that our technology manages. We invited our DOE monitors to visit our booth. Under separate cover, we shall forward to you pictures of our display.

The material secured by the large module is sodium sulfate. It characterizes the salt that accumulates in the bottoms of evaporators at nuclear plants. Being low energy radioactive from nuclear operations, it requires stabilization before disposal. Being highly water soluble its stabilization by present processes is inadequate. Containers are also inadequate for toxic salt management because their contents spill when they are punctured. When distorted, spillage occurs due to rupture of the closure by the lid. And their walls are unable to withstand overburden stresses when they are buried at appreciable depths in the earth. In contrast, no spillage occurs by our modules when subject to harsh mechanical stresses, and overburden stresses must be appreciable to distort them because their consolidated contents rather than their walls manage such stresses.

The key elements of our process are our binder systems that allow ready consolidation of toxic waste (this is a difficult task in plastics technology in the light that consolidation is occuring with 700 pounds of material), and our means to fuse thick, seamless jackets of high performance commodity resin such as polyethylene onto the surface of the consolidated mass. Under EPA sponsorship through the Hazardous Waste Engineering Research Laboratory in Cincinnati, we demonstrated our process on a laboratory scale, under SBIR/DOE sponsorship we proved the process will readily scale to a commercially viable operartion.

According to current reporting in the media Congress and the States will allow future relegating of toxic wastes to the earth in only relatively miniscule quantities. The resulting technical task will be to stabilize concentrated contaminants to withstand earth stresses and yet not incurr more than minimal increase in volume over that of contaminants. This difficult problem is one which our process uniquely addresses. Module containing landfills will be free draining in rainfall in contrast to landfills lined by polymeric liners, thus they would be cost-effectively monitored and maintained. Should the land need to be reclaimed, in contrast to lined landfills, the modular landfill could be readily cleared without need for extraordinary safeguards and equipment.

In just a personal note: We found sponsorship for development of toxic waste management concepts from private sources is not probable when concepts are not analogous to present art and practices. Your SBIR sponsorship is thus very vital in this respect because it leads to demonstration of inventions and innovations. Novel concepts thus evolve into additional viable options for management of hazardous materials. The nation's ability to manage toxic wastes is improved when we increase the number of options that are suitable for addressing the problem. We hope such increase can be made by including our process.

Sincerely,

H.R. Lubowitz
General Manager

HRL/ac
enclosures

SURFACE ENCAPSULATION PROCESS
FOR MANAGING LOW-LEVEL RADIOACTIVE WASTES

S. L. Unger and R. W. Telles
Environmental Protection Polymers, Inc.
13414 Prairie Avenue
Hawthorne, CA 90250

ABSTRACT

Current processes for low-level radioactive waste (LLRW) stabilization involve mixing contaminants with a fixative such as cement, asphalt, polyethylene, or vinyl monomers, and subsequently curing the mixtures in containers. These methods give rise to processing difficulties and yield products lacking performance to assure long-term LLRW immobilization. Mixing of LLRW into fixatives is impeded by viscous media and the curing reaction is inhibited by LLRW constituents. Product performance is affected by corrosion of the containers which ultimately expose the cured mixtures to environmental stresses. Our process, termed the "Surface Encapsulation Process," circumvents these problems. A thermosetting fixative is employed that mixes readily with LLRW and is highly insensitive to inhibition in curing. The agglomerated mixtures are further stabilized by encapsulation with seamless jackets of corrosion resistant plastic, such as polyethylene.

In laboratory-scale investigations, feasibility of our technique was demonstrated for managing a broad spectrum of LLRW simulants including ion-exchange resins, beads, and glasses, and sodium salts. Products tested to date meet all relevant NRC and DOT regulations governing waste fixation. The high waste loadings of the products, use of commodity resins, and processing simplicity indicated our process would provide high performance LLRW stabilization at costs that are competitive to those for processes employing state-of-the-art fixatives. An economic analysis based on managing LLRW generated by commercial power plants (~1,000 MeW) substantiates the competitive process costs advantages.

To carry out full-scale management of LLRW by our process, we have completed construction of a novel process demonstration unit under sponsorship of the Department of Energy. The apparatus stabilizes LLRW in cylindrical 50-gallon modules by agglomerating waste mixtures and powder molding 1/4-inch thick, polyethylene seamless jackets onto the surfaces of the agglomerate. The apparatus is mobile and has capacity to process 3,000-tons of LLRW per year. It features both agglomerating and jacketing molds mounted on a single frame and process controls that are remotely operable.

INTRODUCTION

Low-level radioactive waste (LLRW) management favors waste concentration as the means to realize subsequent cost and safety benefits in waste stabilization, transportation and final disposal. The problem is fabrication of high performance stabilization products with residues that stem from LLRW treatment processes. It is difficult to secure the benefits of waste concentration because fabrication cannot employ more than minimal amounts of fixative.

Current LLRW stabilization processes, in our assessment, would not yield high performance products with concentrated wastes. Even at appreciable amounts of fixative, product mechanical performance and resistance to leachate decreased significantly as contaminant loadings were further increased; in these cases cement, silicate, and asphalt were used as fixatives.(1,2,3) The use of synthetic resins was characterized by difficult processing operations due to their high melt viscosities, or to their reaction chemistry that can cause premature gellation and excessive exotherm. Furthermore, where stabilization entails chemical reaction, chemical pretreatment of the LLRW may be required in order to prevent reaction interference. This operation would increase process costs and the amount of fixative used for stabilization.

The Surface Encapsulation Process provides a viable option in waste stabilization. It stabilizes concentrated LLRW cost effectively with amounts of fixative, and high performance products fabricate readily and reproducibly. In our work industrial contaminants and LLRW simulants were stabilized on a laboratory-scale. We employed a fixative that is unique in waste stabilization and novel surface treatment to reinforce the product. Stabilization was found to occur in the presence of a wide variety of contaminants and a broad range of pH. The products were mechanically tough and resistant to harsh leachates. The process was readily applicable to management of LLRW soluble salts and ion-exchange resins; these wastes being considered to be amongst the most difficult to manage. As a result, we designed and constructed an apparatus to fabricate products simulating our laboratory-scale ones in the commercially viable size of 50-gallons.

This paper reviews our process features, product performance and recent work for managing nuclear grades of ion-exchange resins and soluble salts in concentrations greater than that previously reported in the literature. The paper discusses the fixatives and surface treatment materials employed, the process products, performance of laboratory-sized modules, full-scale processing criteria and economics and the apparatus we have recently fabricated to carry out full-scale LLRW processing. The information is arranged under the headings of: 1) Fixative, 2) Surface Treatment, 3) Product, 4) Process, 5) Product Performance, 6) Apparatus, and 7) Cost Benefits.

Fixative

Our investigative work showed 1,2-polybutadiene and its mixture with powdered polyethylene to have advanced utility in contaminant fixation.(4) These resins thermoset in the curing reaction to yield a chemical structure analogous to cross-linked polyethylene. Such material has excellent chemical stability and withstands mechanical overburden without creep. Unlike synthetic fixatives currently used, the curing reaction of 1,2-polybutadiene proceeds in the presence of a wide variety of contaminants. These benefits are gained due to the resin's hydrophobicity and high functionality. Since the resin will not absorb polar and mineral impurities, these materials do not interfere at the fixation reaction site. The high functionality of the resin gives rise to three dimensional resin networks thereby yielding dimensionally stable products. Thus, chemical pretreatment of the waste is not necessary to structure them for mixture curing.

In contrast to fixatives in which the curing reaction is initiated upon addition of a promoter into the mixture, the curing reaction of a 1,2-polybutadiene is thermally initiated. Thus, currently employed resins cure en toto and generate appreciable exotherms in commercial-size modules. In contrast, mixtures of polybutadiene and LLRW cure incrementally with the surrounding material providing a heat sink. Thus, the temperature of the mixtures in Surface Encapsulation do not exceed their reaction initiation temperature.

Thermally initiated curing and stability at temperatures below threshold also affords other processing advantages. It permits LLRW/fixative blending operations to be carried out without time sensitive constraints such as premature curing of the mixture. It allows the option of storing and inspecting the mixture prior to the formation of stabilized products.

Surface Treatment

Reinforcement of the fixative/polybutadiene agglomerate is accomplished by fusing 1/4 inch thick polyethylene onto the surfaces. This surface treatment is unique in waste management and offers several performance benefits compared to both state-of-the-art waste management surface treatments. The surface treatment that was developed is lamination with impregnation and it is compared to other surface treatments used in waste management: 1) material impregnation, 2) surface coating, and 3) lamination. Material impregnation is exemplified by work carried out at Brookhaven where LLRW are stored in concrete containers. In order to reduce water permeation into the containers, solutions of styrene monomer are applied onto the container and polymerized in situ. Although permeation is reduced, the resultant polymer impregnated cement remains brittle. Examples of surface coatings that are used in waste management include epoxy coated steel drums. Although chemical and corrosion resistance are achieved, no mechanical benefits accrue. Simple lamination is employed in fabricating fiberglass holding tanks. However, the adhesive bonds between layers of substrate are prone to catastrophic failures. Lamination and impregnation of the substrate is unique with respect to the above techniques. It provides a seamless layer of plastic that penetrates into the substrate and causes a 1/4 inch layer of resin above the substrate. The layer acts to reinforce the substrate both mechanically and chemically and also serves as an impervious barrier isolating the substrate from environmental stresses.

Compared to containers used to reinforce state-of-the-art fixative/contaminant mixtures, the Surface Encapsulation jacketing provides enhanced benefits. Containers fail due to corrosion, ineffective closures, and by distortion caused by overburden stresses. The Surface Encapsulation Product is corrosion-resistant and is seamlessly jacketed; i.e., there are no closures. Due to the penetration of the jacket into the waste containing substrate, the waste consignments in the Surface Encapsulation products are load bearing. By using a flexible jacketing resin, the hazardous consignments remain secure even in severely crushed products. The jackets can be readily repaired if damaged.

Product

The stabilized waste products are characterized by 1/4 inch thick polyethylene seamless jackets fusion bonded onto agglomerates of LLRW concentrated in a matrix of compacted polyethylene and polybutadiene. The resin jackets provide radiation stable reinforcement of the fixed contaminants, thus yielding waste forms that assure high performance contaminant stability under harsh environmental stresses.

Commercial-size modules that are currently under development are cylindrical and approximately 50-gallon in capacity. The module diameter is approximately 24 inches, similar in diameter to a 55 gallon drum. Thus, the modules can be managed by conventional drum handling equipments. Cylindrical modules were specified also to dissipate heat from modules containing LLRW. Modules can be readily fabricated in other sizes and configurations, such as cubic in order to conserve landfill space. The 50-gallon modules that we are developing will weigh between 300-600 lbs depending on the density of LLRW. Approximately 50 lbs of resin are needed to fabricate the modules; 25 lbs of fixative and 25 lbs of jacketing resin. The fixative and jacket add less than 5% to the waste volume.

Process

Full-scale processing of LLRW is based on procedures developed in laboratory-size module fabrication and entails three major steps: 1) mixing waste with PB binder, 2) agglomerating the mixture to yield a core, and 3) encapsulating the core with a resin jacket. These processing steps are discussed below.

Mixing wastes and the resin has been carried out in a low-compression laboratory extruder and in a stirred vessel with solvent diluted resin. Mixing undiluted liquid resin obviates the need for solvent recovery in full-scale processing. Because resin melting is not required in mixing, low compression extruders can be utilized which reduces power requirements, screw wear, and is simple to control compared to other extrusion operations used in waste management. In our work, the LLRW and the PB binder are fed to separate input ports at measured rates. In laboratory work, the resin is gravity fed through a metered orifice and the LLRW is transferred by a vibratory feeder. The resin and the extruder barrel are heated to approximately 150°F to reduce resin viscosity and facilitate mixing. Full-scale processing can be accomplished at temperatures as high as 350°F to remove free water in the waste input and achieve maximum volume reduction. Full-scale processes can also utilize batch mixing equipment such as ribbon blenders and mills for waste/binder mixing.

The waste/binder mixture is then transferred to the apparatus where it is first agglomerated and then encapsulated. Agglomeration is carried out by compression molding in which the mold is heated and minimal pressure is applied to the mixture. The shape and size of the agglomerating mold determines the dimensional nature of the final product. As explained earlier, we are currently designing 50-gallon cylindrical modules; however, rectangular modules can be fabricated in order to conserve landfill volume. Molds can be heated directly by electrical heaters or steam or indirectly in curing ovens. Cure time is dependent on thermal conductivity of the waste material. We estimate a cure time of 1-6 hours for commercial-size agglomerates.

In the final step, the waste agglomerate is jacketed with polyethylene by powder molding. The waste agglomerate is loaded into a matched mold, i.e., a mold geometrically similar but slightly larger than the agglomerate. Powdered polyethylene is then loaded into the interstitial space between the agglomerate and the jacket mold and on the top surface of the agglomerate. The jacket is consolidated and bound to the agglomerate by heating the powder so that it melts and fuses and then cooling the melt so that it solidifies. The partially jacketed agglomerate is inverted and additional polyethylene is added over the unjacketed surface and the jacketing is completed.

Product Performance

Laboratory-size products were evaluated for both mechanical performance and resistance to leachate stresses. Under EPA sponsorship, over 100 laboratory-scale modules with 90% by weight hazardous content were prepared and evaluated. The modules held residues of the following dewatered sludges: electroplating, nickel-cadmium, SO_x scrubber, paint pigments, chlorine production brine, and calcium fluoride.

The following mechanical performance was observed: under uniaxial mechanical compression, modules withstood appreciable pressure before deformation because the consolidated contents distributed the applied load and the matrix resin resisted creep due to its chemically cross-linked nature. Under extreme pressure the modules yielded, but even when severely distorted there was no content loss because their jackets provided flexibility and toughness which functioned to envelope the contents and keep them intact. Under impact by dropping, modules remained intact upon landing on a steel plate. We estimated it would require extraordinary impact to rupture a module, and even then there would be no spillage of waste contents because they are fixed in a resin matrix. In puncturing by pointed steel probe, appreciable force was required to penetrate the jackets because they were both tough and reinforced by being bonded to the surfaces of the resin matrix agglomerated contaminants.

Further evaluations of modules were carried out with respect to their physical and chemical performance. At the Corps, modules were subject to wet-dry and freeze-thaw conditions, and to leaching by constant water flow for over three years. The Corps reported that modules exhibited stability in all cases; their performance exceeded the performance of other fixation products examined. In our work under EPA sponsorship, we found modules to be stable under extreme thermal shock. They were cycled from a -10°C salt/ice bath to 100°C boiling water, a cycle being of 15 minutes duration with 16 cycles per day over ten days with storage of samples overnight in a freezer. There was no apparent damage to modules and their compressive strengths were at least 95% of their original values.

In further work under EPA sponsorship, we also examined the stability of modules when subjected to harsh leaching solutions such as caustic, hydrogen chloride, citric acid, ammonium hydroxide, ammonium sulfide, and dioxane. In all cases, the modules were found to be stable and exhibit high retention of their hazardous contents. We estimated in our review of state-of-the-art fixation processes that current fixation products would not withstand such harsh leaching solutions. In further leaching studies, we demonstrated the ability of modules to hold 95 weight percent salt under water leaching. In this case, we also speculated that current fixation products would not exhibit such performance when similarly loaded with soluble, inorganic material.

Apparatus

We are currently completing construction of a prototype apparatus for managing LLRW in commercial-size modules. The apparatus carries out the agglomerating and jacketing process steps; its major components are the two molds which are mounted on a single frame. The apparatus features an indexing table for loading the agglomerate into the jacketing mold. The design criteria for the prototype apparatus include: 1) capability for managing ~300 tons per year of radwaste, 2) transportable, and 3) remotely operable. Thus, the apparatus can function in full-scale LLRW processing demonstrations behind a radiation barrier.

Both the agglomerate and the jacket molds are heated by electrical band heaters and have drilled-in cooling channels for water cooling. A hydraulic system actuates and pressurizes the molds. The agglomerate mold body is a cylindrical steel shell 23-1/2 inches in diameter. The platen fits inside the mold body to pressurize the waste/binder mixture. The mold base is mounted on a linear positioning table that transports the agglomerate to the jacket mold. The jacket mold that fits around the agglomerate is a clamshell mold to facilitate product removal and is capable of being rotated 180° for jacketing by powder molding.

The apparatus is microprocessor controlled for remote operation and the control system is capable

capable of operating the entire process automatically including: heating and pressurizing both molds, regulating cooling water, indexing agglomerate to jacketing mold, rotating the jacket mold, and indexing the module to the unloading platform.

Cost Benefits

A significant feature of our process is employment of low-cost, mass produced materials. The resins we employ stem from ethylene and butadiene marketed at $0.20 and $0.50 per pound, respectively. These compounds are well known, produced commercially in large amounts, and are used to make polyethylene containers and film, and polybutadiene tires for vehicles. We employ in our jacket fabrication process powdered polyethylene, which is vended to the rotomolding industry for producing holding tanks for fertilizers and harsh chemicals. Powdered polyethylene is presently marketed at approximately $0.45 per pound. Polybutadiene that we employ for fixing contaminants is of the type that is employed in Japan and the U.S. for making corrosion-proof steel frames for automobiles by resin coating them in an electroplating process. The material is offered domestically at about two dollars per pound. By blending the material with polyethylene, we estimate about $1.25 for binder resin. The cost of materials to fabricate a 40 gallon module is estimated to be approximately $40.00. Since foreign sources offer polybutadiene for about 80 cents per pound, potential exists for significantly reducing costs of the material obtained from the domestic market.

The price for polybutadiene is based upon electrodeposition grade material. We estimate a significant portion of its cost lies in its purification for this purpose. Our process, however, does not require a pure material. Consequently, in view of the foreign price and the suitability of cruder polybutadiene for our process, we estimate a significant reduction in cost for this resin is potentially realizable.

In comparison to material costs for other LLRW fixation and containerization schemes, the materials used for managing wastes by Surface Encapsulation are significantly less costly than the materials used in other processes. Table 1 presents a material cost comparison for fixation processes based on cementitious materials, asphalt, polyester, polybutadiene/polyethylene (Surface Encapsulation), and containerization with High Integrity Containers.

The cost comparison focuses on spent resin solidification. The values used for the waste-to-binder ratios represent widely accepted processing aggregates derived from the technical literature. Costs for High Integrity Containers are based on vendor quotations. The costs are presented on a dollar per pound of treated ion-exchange resin.

Table 1 shows that the Surface Encapsulation Process is the least expensive option for managing spent ion-exchange resins due to the high waste loadings achievable by Surface Encapsulation. Polyester and cementitious solidification systems, and high integrity containerization are significantly more expensive management options. These cost advantages are estimated also to apply to other LLRW such as evaporator bottoms or other ion-exchange media. In addition to material cost advantages, Surface Encapsulation will result in lower transportation and disposal costs due to high waste loadings and, thus, low volume added in the modules.

TABLE I

Comparative Material Costs for LLRW Management

LLRW FIXATIVE BINDER	BINDER COST $/LB BINDER	FIXATIVE: ION-EXCHANGE RESIN WT. RATIO	COST OF ION-EXCHANGE RESIN MANAGED $/LB RESIN
Cementitious Sodium Silicate	$0.06/lb	10:1	$0.60
Asphalt	$0.20/lb	3:2	$0.30
Polyester	$0.75/lb	2:3	$0.50
Surface Encapsulation	$1.25/lb	1:10	$0.12
HIC	$225/55-gal drum	420 lb/drum 55 lb/ft	$0.60

REFERENCES

1. P. COLOMBO and R. M. NEILSON, Jr., "Waste Form Development Program Annual Progress Report," October 1981 - September 1982, BNL-51614, 1982.

2. MALONE, et. al., "Guide to the Disposal of Chemically Stabilized and Solidified Waste," USEPA SW-872, 1980.

3. W. F. HOLCOMB and S. M. GOLDBERG, "Available Methods of Solidification for Low-level Radioactive Wastes in the United States," U.S. Environmental Protection Agency, Office of Radiation Programs, ORP/TAD-76-4, December 1976.

4. LUBOWITZ, et. al., "Development of a Polymeric Cementing and Encapsulating Process for Managing Hazardous Wastes," U.S. Environmental Protection Agency Report, EPA-600/2-77/045, 1977.

KENAF
INTERNATIONAL

December 11, 1985

Mr. Roland Tibbetts
Program Manager, SBIR
National Science Foundation
Room 1250
1800 G Street, N.W.
Washington, DC 20550

Dear Mr. Tibbetts:

It is my pleasure to bring you up todate with Kenaf International. As you know, much of the current activity focussing on this exciting new crop for U.S. and world farmers can be traced back to a 1977 Phase I SBIR grant by the National Science Foundation to SaLUT, which subcontraced with the Agricultural Economics Department of the University of Missouri to develop a systems approach to expedite the introduction of new crops.

My dissertation research centered on the commercial development of kenaf. I was employed by SaLUT as Project Manager for the follow on feasibility studies conducted for the American Newspaper Publishers Association in the United States and for the U.S. Trade and Development Program in Belize. Each study represented about $200,000 of consulting.

In late 1981 SaLUT was joined by two companies from Bakersfield, California (The Bakersfield Californian and Agrifuture, Inc.) In 1983 SaLUT left the joint venture and I joined as partner and General Manager. I have enclosed (1) a copy of our brochure, (2) a copy of our 1982 report to the publishers, (3) a list of kenaf milestones, and (4) information regarding the re-entry of the USDA into kenaf.

Finally, I have shared a clipping from The Monitor of McAllen, Texas. I have noted a couple misquotes, but the prospects are most promising that a SBIR grant in 1977 might result in a $150 million investment by 1986. As I mentioned, a similar project is also under consideration in Puerto Rico.

I hope that these brief remarkes and the various enclosures serve as indicators of the crucial importance of the NSF/SBIR Program. Please note the change in our East Coast Address and let us know if we can be of assistance.

Enclosures

cc: J. Stanners
G. Fisher

Sincerely,

Charles S. Taylor, General Manager

EAST COAST OFFICE
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WEST COAST OFFICE
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ATTACHMENT A

A RECENT HISTORY OF KENAF & KENAF INTERNATIONAL

KENAF INTERNATIONAL is a California based joint venture company owned by The Bakersfield Californian, Agriculture, Inc., and Dr. Charles S. Taylor. The company (or its principals) has been directly involved in the development of kenaf technology since 1979. Some of the milestones of these activities are briefly described as follows:

1979 -- The American Newspaper Publishers Association (ANPA) and the International Paper Company produced newsprint from 95 percent kenaf pulp at its mill in Pine Bluff, Arkansas. Six U.S. newspapers (including the Wall Street Journal, Miami Herald, and Yuma (AZ) Daily Sun) successfully printed on the kenaf newsprint and found its quality to be comparable to newsprint produced from conventional wood fibers.

1979 -- Taylor began research on the development of a systems approach for the introduction of kenaf as a new crop for U.S. farmers as part of a project at the University of Missouri financed by a grant from the National Science Foundation.

1980 -- ANPA commissioned a team headed by Taylor to conduct further studies on utilizing kenaf for newsprint in the United States. This resulted in the 1982 publication of the report entitled "Kenaf Newsprint System".

1981 -- Further pulping trials at International Paper's Mobile, Alabama mill produced more kenaf newsprint, which was printed on successfully by eight U.S. newspapers.

1981 -- The Phoenix Pulp and Paper Company initiated production of kenaf kraft pulp at its new 200 tpd mill in Northeast Thailand. This is the first greenfield mill to be built to use kenaf as its primary fiber source. Kenaf International maintains close contact with Phoenix and is discussing ways in which KI might participate in supplying fiber to the mill.

1981 -- Kenaf International was formed and registered in the State of California. Its first activity was to invest in the multiplication of kenaf seed in Texas in order to create a seed reserve sufficient to facilitate the development of kenaf projects.

1982 -- The First International Kenaf Conference was held in conjunction with the ANPA Annual Meeting with more than 100 participants from 17 countries in attendance.

1982 -- Kenaf International was commissioned by the U.S. Trade and Development Program at the request of the Government of Belize to study the feasibility of a kenaf based pulp and paper project in that new Central American country.

1982 -- Test plots of kenaf were planted at several sites in the United States, Puerto Rico, and Belize.

1983 -- A prefeasibility study was conducted in the Dominican Republic, which included successful growing trials.

1984 -- The United Nations Development Programme (UNDP) commissioned the growing of kenaf at ten sites in Pakistan. This effort was continued in 1985 in an attempt to meet Pakistan's growing needs for fiber from local sources.

1984 -- Work began on a prefeasibility study in Puerto Rico. The results of this study are presently being reviewed by the Puerto Rican Government.

1985 -- Kenaf International made additional studies in Trinidad and Italy regarding kenaf.

1985 -- Kenaf International grew 66 acres of kenaf in order to provide sufficient seed for proposed USDA 1986 Kenaf Demonstration Program.

1985 -- Kenaf International began investigations into the possibility of establishing a major newsprint mill in the Lower Rio Grande Valley near McAllen, Texas.

American Association of Nurserymen, Inc.
1250 I Street, N.W., Suite 500, Washington, D.C. 20005 (202) 789-2900

March 11, 1986

The Honorable Warren Rudman
Chairman
Subcommittee on Innovation and Technology
Senate Committee on Small Business
428 Senate Russell Office Building
Washington, D.C. 20510

Dear Senator Rudman:

The American Association of Nurserymen (AAN) enthusiastically supports the Small Business Innovation and Research Act which you authored in 1982. SBIR is an important incentive to small businesses to meet federal research needs and developments and transform the results into new commercially available products and services.

As you know, AAN is the national trade organization of the nursery, landscape and garden center industries. If you were to characterize our 3,400 member firms, you will find that we are an association composed overwhelmingly of small businesses.

In the short time since the implementation of SBIR, our industries have quickly come to regard SBIR as an extraordinarily worthwhile program which has been designed to channel federal government research dollars to small business research and development funding. Nursery industry firms have received SBIR grants from the Department of Agriculture in the following research areas: forests and related resources; plant production and protection; air, water and soils; and, rural and community development.

The importance of SBIR must never be underestimated for here is a program which specifically earmarks federal research dollars to small businesses. Were it not for SBIR, most of these research dollars probably would never find their way to small businesses which are the backbone of this great nation and from which many of today's technological and commercial innovations are developed.

We are confident you and your colleagues will agree that SBIR dollars have already proven to be wise investments in having spurred the development of significant and new introductions into the marketplace. AAN believes SBIR is achieving the noble goals which you established for the program and we commend your continued leadership and interest in this important area.

On behalf of the American Association of Nurserymen, I hereby respectfully request that this statement be submitted into the record of the hearings on SBIR's effectiveness.

Sincerely,

Benjamin C. Bolusky

Benjamin C. Bolusky
Director of Government
Affairs

BCB:tt

CID-78

VERAX CORPORATION

P.O. Box B-1170 • Hanover, N.H. 03755 • (603) 448-4447

February 21, 1985

Mr. Roland Tibbetts
Program Manager, SBIR
Division of Industrial Science and
  Technological Innovation
National Science Foundation
1800 G Street NW
Washington, DC 20550

Dear Roland:

This letter is a summary of the involvement that Verax has had with the Small Business Innovation Research (SBIR) program and the commercial results we have achieved with it.

Verax is a very small company (60 employees), expecting to grow by 1990 into a major producer of high-value biochemicals (made by the culture of living cells) for the medical, agricultural, veterinary and specialty-chemical markets. Our special strength is unique manufacturing-process technology, which is proving to reduce greatly the cost of high-value biochemicals. We are focusing now on monoclonal antibodies and mammalian-cell products such as hormones, blood factors and lymphokines. These products promise to be revolutionary in the diagnosis and treatment of diseases such as cancer, arteriosclerosis, AIDS, arthritis, and diabetes.

Genetic engineers and molecular biologists have discovered recently very promising biochemicals to attack these diseases in uniquely-powerful ways. But many of these biochemicals are extremely costly to manufacture today. Verax is devoted to reducing the cost of manufacture by orders of magnitude, thus making these exciting new pharmaceuticals practical for human therapy. We believe that our efforts are critical to realizing the enormous potential of modern biology. We believe that medicine is at the frontier of a golden age when most of man's great scourges will be conquered. And, we believe that our process technology will be crucial to making this golden age a practical reality for man, for his crops and for his domestic animals.

Despite these visions, it has been difficult for Verax to fund its development. Reducing the cost of new drugs is not nearly as glamorous as discovering and proving the drugs. So we have had a "long march" since 1980 to invent the means, prove them at the pilot-plant level and then bring them into commercial production. In this arduous and often discouraging venture, the winning of SBIR funding, even though a small fraction (3.2%) of what we have spent on R&D, has been most encouraging. Just the fact that our research program has been blessed by NSF and NIH peer reviews has given us the courage to continue. And the money has allowed Verax to perform the basic research that underlies our technology. Basic research that we could not have performed with our scarce funds, but which has lead to major commercial advances in the performance of our manufacturing process.

For example, we have reduced the production cost of monoclonal antibodies by at least four times below the costs of all other processes known to us. This achievement has won us production contracts already from several well-known pharmaceutical and genetic engineering companies. Most of these companies are preparing clinical trials for their new pharmaceuticals. They want to write the Verax production process into the protocol for their FDA New Drug Applications (NDA). So, with our commercial production of monoclonal antibodies starting in September 1984, and our customers writing our manufacturing process into their NDA's, the fruits of SBIR basic-research sponsorship have already reached the marketplace.

I have no doubt that Verax's venture has been powerfully stimulated by the NSF and NIH SBIR grants which we have received. The winning of these grants has also encouraged private investment in Verax by individuals and by sophisticated, large companies.

HISTORY OF SBIR SUPPORT

In 1981, Verax made an arrangement with Professor K. Venkatasubramanian of Rutgers University for an exclusive license to exploit his technology of continuous-fermentation with immobilized microorganisms (CF IMMO) for the production of biochemicals from living organisms such as bacteria, yeast, and the cells of animals and plants. Venkat became a major Verax stockholder, a Director, and chairman of our Scientific Advisory Board. In the early days, he directed our research.

In April 1982, Dean and Venkat as Co-PI's made our first SBIR Phase I proposal to NSF to research long-life catalysts for CF-IMMO production of ethanol, as a starting base case. This grant was received in the Fall of 1982 and the project was completed with significant results reported in April of 1983. Verax supplied monies equal to several times the NSF/SBIR funding (about $30,000) to implement this research. At that time, our laboratories, staffed with Verax people and some part-time students, were located in the facilities of Dartmouth College (where I and some of my colleagues are adjunct professors). Dartmouth has made a crucial contribution to Verax's venture by allowing us use of their facilities at cost. Without their space, purchasing discounts, electron microscopes, flow cytometer, hybridoma lab, etc. and faculty consulting advice, we would never have succeeded. Some of the NSF/SBIR Phase I money went to support student work, which they saw was important to their career choice of biotechnology. So NSF/SBIR funds have contributed, albeit in a small way, to resolving the severe shortage in the USA of biochemical engineers.

From the joint NSF/SBIR-Verax research program came a new biocatalyst for bacterial and yeast CF-IMMO ferments. This has been reported to the American Chemical Society and the American Institute of Chemical Engineers in 1983 papers and is in press for Biotechnology and Biotechnology and Bioengineering journals.

Also, unique research hardware was developed and a unique Fermentation Kinetics Laboratory, which serves us powerfully by supplying vital data for the engineering of our production-process systems.

This first NSF/SBIR Phase I project was small, but it came at a seminal time when we had very little money for basic research. Its fruits have grown from these seeds into our present-day CF-IMMO commercial production plant. Also, a well-known and very large laboratory-equipment house has nearly completed a licensing agreement with Verax to inject our CF-IMMO cell-culture hardware system, nutrients and cell-immobilizing matrix into the international biological research laboratory market. So, within three years, NSF/SBIR sponsored research will have been commercialized via our commercial production now and the pending availability of the CF-IMMO apparatus and expendables to all biotechnology researchers.

Because of the funding hiatus in the NSF/SBIR program, our follow-up Phase II grant, which was approved in the Fall of 1983, is just now being implemented in early 1985.

In April 1983, we applied for a NIH/SBIR Phase I grant to extend CF-IMMO to mammalian cells, and this was granted in the Fall of 1983. This research proved that conventional hydrocolloid-gel cell-immobilizing matrices were not attractive for hybridoma cells. Instead, a unique sponge-matrix was identified. Using commercially-available microsponges, we demonstrated interesting CF-IMMO performance. Phase II funding is expected to start in April 1985. (The Phase II funding was delayed by a difficult change in PI.)

We also have several pending SBIR Phase I proposals to extend our CF-IMMO research to mammalian cells in general, and to explore the detailed biochemistry of CF-IMMO cell cultures.

In all of this research, Verax has always supplied matching funds exceeding greatly the SBIR funding. And for all of these SBIR projects, we have used at least one counselor from academia. Last summer, Verax moved all of its laboratory operations into its own facilities in Lebanon, New Hampshire. So Dartmouth does not lend its physical facilities now on a regular basis. But, we do have constantly-increasing involvement with the faculties of the Medical School, the Engineering School and the Biological Sciences Department of Dartmouth, and with the Chemical Engineering Department of MIT.

RESULTS OF SBIR SUPPORTED RESEARCH

Verax's research since 1982 has generated a complete process for the mass-culture of mammalian cells by CF-IMMO.

A patent application has been filed for our proprietary bioreactor. It utilizes a fluidized-bed of 200 μm IMMO-matrix beads. The slurry is very dense and the cell concentrations inside the matrix are 10 to 100 times higher than for conventional cell culture. So the reactor-volume cell concentration and consequent reactor space-time productivity is 10-100 times conventional performance. This gain cuts the reactor capital cost commensurately. With our unique membrane gas exchangers in the external recycle loop, the reactor can achieve 10 times the oxygen delivery rates of the best conventional deep-tank, stirred reactors. Consequently, we have removed aerobic limitations on commercial production of biochemicals from bacteria and yeast, and for mammalian cells without using shear rates which damage cells.

The sponge-type immobilizing matrix and its manufacturing process has been highly perfected (not using US government funds). Several patents are now applied for on the matrix material, on the manufacturing technique and on the use of this type of matrix in our fluidized-bed bioreactor. The Verax IMMO-matrix beads are heavily-weighted in order to achieve IMMO-bead specific gravity up to 2.0 for efficient fluidization giving high mass-transfer rates between the beads and the culture liquor. Nothing like our IMMO-beads for immobilizing cells are known in the art. A large company has proposed to manufacture and sell our IMMO matrix to the research and industrial markets.

Our research, partly supported by SBIR funds, has also extensively studied and optimized culture nutrients. We have achieved a medium containing only 2 μg/ml of protein, which greatly lowers the cost of product purification by increasing chromatography column capacity. Further, this medium yields higher cell productivity and harvest-liquor product concentration than any other medium we know, and it costs 1/10th the current market price of commercial media. We are patenting our IMMO-media formulas. A large chemical company is negotiating with us now to make and distribute our media to the research and industrial markets.

In order to further enhance output, our related research (not supported by the US government) has discovered unique drugs that control cell metabolism and growth. With these and a proper bioreactor operating protocol, we have achieved 3-5 times incremental gain. A patent application filed with the U.S. Patent Office on this invention too.

Overall, our research has raised monoclonal antibody output by an order of magnitude and cut the cost of production by 4-15 times, depending on which of our competitor's methods are compared. Our production-cost analyses indicate that CF-IMMO-produced monoclonal antibody production costs are 1/4 of our nearest competitor's costs. And, we do not know any way our competitors in the USA and abroad can achieve major cost reductions in order to approach our production economics. For example, Celltech in Britain, our largest competitor, has announced that they will commence using chemostats in late 1985 instead of the conventional batch, air-lift deep cultures which they now employ. Our analysis indicates that at end 1985, their "advanced" manufacturing means will be on the order of 10 times more expensive for the manufacture of monoclonal antibodies than our CF-IMMO system.

Our research is now applying these advantages to mammalian-cell culture. These advantages are desperately needed because some cells produce exquisitely minute amounts of product. Some mammalian-cell products like hormones today cost to $1 million per gram. For practical medical use, this cost must be reduced by 100 to 1000 times. We are of the opinion that our CF-IMMO system has the best potential to achieve this reduction. And numerous genetic-engineering and pharmaceutical houses, who have examined our process, appear to agree with us. We will apply pending NSF/SBIR and NIH/SBIR Phase II grants to basic research enabling this goal.

Verax is now negotiating licenses with several major manufacturers in order to employ our CF-IMMO process, immobilizing matrix and special nutrients for their product manufacture.

CONTINUING SBIR RESEARCH

We continue vigorously to propose new Phase I and Phase II SBIR projects from NSF and NIH. Because we are still very limited in resources, SBIR support has a very large impact on what we can do to develop new products and lower further our production costs.

Our main research focus now is on the biochemical environment within the bioreactor. Several NIH/SBIR proposals have been submitted in 1984 along this line. The biochemical environment is very complex. The injected nutrients contain the order of 20 components. The cells manufacture tens of byproducts any of which could inhibit metabolism of the wanted product or destroy or modify it before harvest. Some of these byproducts may be very undesirable in the purified pharmaceutical (e.g. endotoxins from genetically-engineered *E. coli*). With conventional culture technique, research to unscramble this huge chemical puzzle is very difficult, if not impossible. With our continuous culture technique, the research becomes possible, but is still very time-consuming and expensive. So we have invented a new, very quick research tool, which we are patenting too. Its demonstration is the proposed subject of a recent NIH/SBIR Phase I proposal. We feel that the promise of this apparatus is enormous. Gains in productivity and harvest concentration of 10-1000 times may be realized, with a consequent great reduction in the production cost of products from low-producing mammalian cells.

Finally, our most advanced and basic research concerns "cell-engineering", that is to literally redesign living cells for over-production of the biochemical product. Genetic engineering is one tool of cell engineering. But, we think that there are many more by which we can speed up protein synthesis and secretion. Both conventional mutagenesis and directed manipulation of the cytophysiology and morphology will be employed.

Verax has acquired an increasing cadre of molecular and cell biologists and biochemists, who are closely integrated with our engineers, in order to effect this research. Our latest recruit is a world-class molecular immunologist. He and other Verax researchers will be proposing SBIR programs to NIH and NSF in order to research the culture environment and do the "cell-engineering" research sketched above.

PHASE III FINANCING OF COMMERCIALIZATION

Verax is carrying the fruits of its SBIR-sponsored research to the US and foreign markets in the form of high-value protein products, both Verax-proprietary and custom-manufactured for customers, and via licenses allowing use of our technology in licensees' manufacturing plants.

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So we assert that SBIR research support at Verax has and will continue to have strong benefits for the US economy just as intended by Congress. We now employ about 60 people, up from 4 when we started in 1979. We expect to employ the order of 1000 by 1990. The creation of all of these new jobs was implemented critically by SBIR funds.

CONCLUSION

The US government's SBIR operation is founded on correct principles supported by the long history of industrial innovation. It has great potential at the seminal level where a little input makes a great difference. To catalyze private industry is a proper role of government. SBIR does just that. I believe that the SBIR program is the very best investment of the US government because it augments America's greatest economic strength, the peculiar entrepreneurial innovativeness of its citizens.

Sincerely yours,

VERAX CORPORATION

RC Dean

Robert C. Dean, Jr., ScD
Chairman and Director of
Science & Technology

RCD/evd

STATEMENT FOR THE RECORD

U.S. DEPARTMENT OF COMMERCE

BEFORE THE

SUBCOMMITTEE ON INNOVATION AND TECHNOLOGY
U.S. SENATE COMMITTEE ON SMALL BUSINESS

MARCH 11, 1986

Mr. Chairman and Members of the Subcommittee:

The Department of Commerce is pleased to submit this overview of our participation in the Small Business Innovation Research (SBIR) Program. The program requires a set-aside of an increasing percentage (0.2%, 0.6%, 1.0%, 1.2% over 4 years) of our extramural R&D budget to technologically sophisticated small businesses to find new and innovative approaches to our research problems.

Commerce's SBIR program, in terms of funding is small. However, our research programs cover a broad spectrum of disciplines in the environmental and physical measurement sciences. The Department's program was initiated in 1984, when, for the first time, the Commerce R&D budget exceeded $100 million. The amount of extramural R&D in our FY 84 budget was

$103.9 million, requiring $208,000 to be set aside during that year for participation in the program. To provide an opportunity for a broad spectrum of small business research in accordance with Commerce's diverse interests, the maximum funding limits were set at a relatively low $30,000 for phase I and $200,000 for phase II.

The National Oceanic and Atmospheric Administration (NOAA) accounts for nearly 90% of Commerce's extramural R&D. For this reason, and to facilitate the prompt publication of the Department's first program solicitation, NOAA implemented and managed the program for the Department. For the first year, NOAA provided the entire budgeted amount set aside for the Department's program and the first solicitation included only research topics of interest to NOAA. For subsequent years the program was expanded to include other Commerce bureaus with extramural R&D budgets and the solicitation included research topics of interest to them.

The first Commerce SBIR program solicitation was released on October 15, 1984. Over 3,000 copies were provided to small businesses. That solicitation included research topics in the atmospheric and hydrological sciences, ocean science and engineering, living marine resources, space and surface based remote sensing, and environmental data applications. In response, 154 proposals were received and seven awards were made totaling $204,000. At least one proposal in each of the research topics mentioned above received an award. All seven companies have submitted phase II proposals with follow-on funding commitments totaling over $1 million.

The second Commerce SBIR program was released on October 15, 1985, this time with research topics included from the National Bureau of Standards and the Bureau of the Census as well as NOAA. In response, 184 phase I proposals were submitted and 179 are currently in the review and evaluation process.

The FY 85 Commerce extramural R&D budget was $100.4 million and the amount set aside for the second year for 0.6% of this, or $602,200. These funds plus about $250,000 of the FY 86 set-aside will be used to fund eight or nine new phase I proposals and three phase II proposals from the original seven phase I projects.

To summarize, Commerce has expended $204,000 on seven phase I awards at approximately $30,000 each and, as of this hearing date, has made no phase II awards. However, by May 1, 1986 we will obligate $600,000 for three phase II awards at $200,000 each and a total of approximately $250,000 in phase I awards at $30,000 each.

The Department of Commerce program is less than two years old and we are only now about to make our first phase II awards. Therefore, assessment of the program based on the quality of research done and its impact on our programs would be premature. However, if we were to assess the program based upon the quality of the proposals we have received and the feasibility studies which were done in phase I, it is quite clear that the SBIR program has the potential for making a significant contribution to our R&D efforts. Further, third party interest in the technologies that may emerge from phase II, as expressed in follow-on funding commitments, suggest that these technologies would indeed have commercial value.

Finally, we have had no significant problems in implementing the program. The policy guidance and program coordination provided by the Small Business Administration has been clear and helpful.

We thank you for the opportunity to provide testimony on the the Department's SBIR program and hope that it will be helpful to the subcommittee.